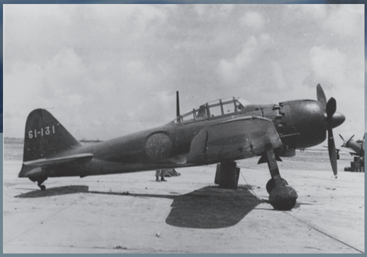
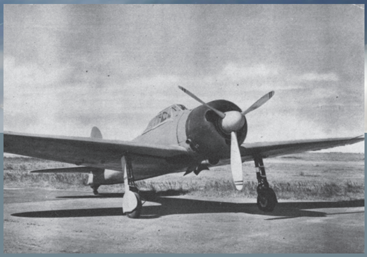
MITSUBISHI A6M ZERO





JAMES D'ANGINA

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AIR VANGUARD 19

MITSUBISHI A6M ZERO

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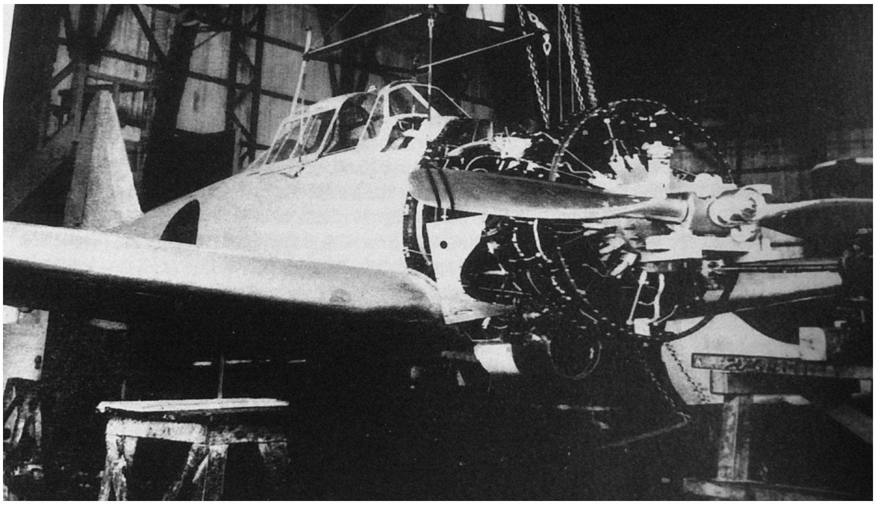
MITSUBISHI A6M ZERO

INTRODUCTION

The Mitsubishi A6M Zero carrier-fighter was Japan's premier fighter of World War II and remains one of the most revered and iconic aircraft in Japanese aviation history. The Mitsubishi Zero's ability to best Allied fighters early in the war caught the West by surprise. Its impressive range, rate of climb, and ability to turn inside Allied fighters – due to its low wing loading – gave Imperial Japanese Naval pilots a distinct advantage in dogfights. The Zero's maneuverability, particularly in the hands of Japan's highly trained (and often combat-experienced) aviators led to an impressive 12-to-1 air-to-air kill ratio early in the war.

Its performance came as such a shock to the West that allegations arose that the fighter was not an indigenous design. Mitsubishi's new carrier-fighter drew upon the lessons learned from building its predecessor, the A5M (the world's first operational monoplane carrier-fighter), as well as utilizing the latest advances in aviation technology. After the Allies had a close inspection of a captured A6M, the Zero was found to be unique in its construction, notably for its use of extra super duralumin (ESD), a one-piece wing integral to the fuselage to enhance strength, and advanced weight reduction techniques used to offset its underpowered engine. Distinguishable features included its



The A6M1 flying prototypes were powered by Mitsubishi-built Zuisei 13 radial engines, and used a two-bladed Hamilton Standard constant speed propeller (built under license by Sumitomo). (IJN)

An A6M2b Zero prepares for takeoff from the IJN carrier *Shokaku* during the Pearl Harbor attack, December 7, 1941. Ground crew members prepare to remove the wheel chocks as the pilot readies to launch from the deck. (NARA)

greenhouse canopy (giving its pilot a 360-degree view) and its straight, tapered wings with narrow, rounded wing tips. Lessons learned during the Second Sino-Japanese War, combined with the nearly impossible requirements set forth by the Imperial Japanese Navy (IJN), helped shape the Zero. Mitsubishi's engineers, led by Jiro Horikoshi, built a fighter which would not only meet these unwavering requirements, but in many cases surpass them, creating the world's first single-engine long-range escort-fighter, and the first carrier-fighter to truly outperform its land-based counterparts.

The Zero's dominance did not go unnoticed during the lead-up to the war in the Pacific. Experts like Claire Lee Chennault warned the West about Japan's latest fighter, but his warnings fell on deaf ears. When the Mitsubishi A6M2 (Model 11) first made its appearance over China, Chennault was astonished by the plane's dominance. Seeing firsthand the destruction of the Chinese Nationalist Air Force as a fighting force in action over Chungking, he said that "like hawks in a chicken yard they shot down the Chinese fighters before the defenders knew what hit them." During a trip to Washington in October 1940, Chennault brought with him information on the IJN's newest fighter; his warnings were once again ignored.

Failed intelligence, coupled with inexperienced Allied fighter pilots, contributed to the A6M's early success. With the aid of captured Zeros found in China and the Aleutians, American military officials studied the Zero's strengths and weaknesses. Its lightweight construction limited how fast it could dive. Its large ailerons, responsible for great maneuverability at low speeds,

FATHER OF THE ZERO

Dr Jiro Horikoshi was born on June 22, 1903, in a rural area near the city of Fujioka, Gunma Prefecture, Japan. Jiro's fascination with aviation began at an early age, when he developed an interest in World War I fighters and stories of air battles over Europe. During his elementary years he dreamed of building his own aircraft and flying over the Japanese countryside. His passion for aviation faded while attending Fujioka High School, and he assumed his career would take a different path.

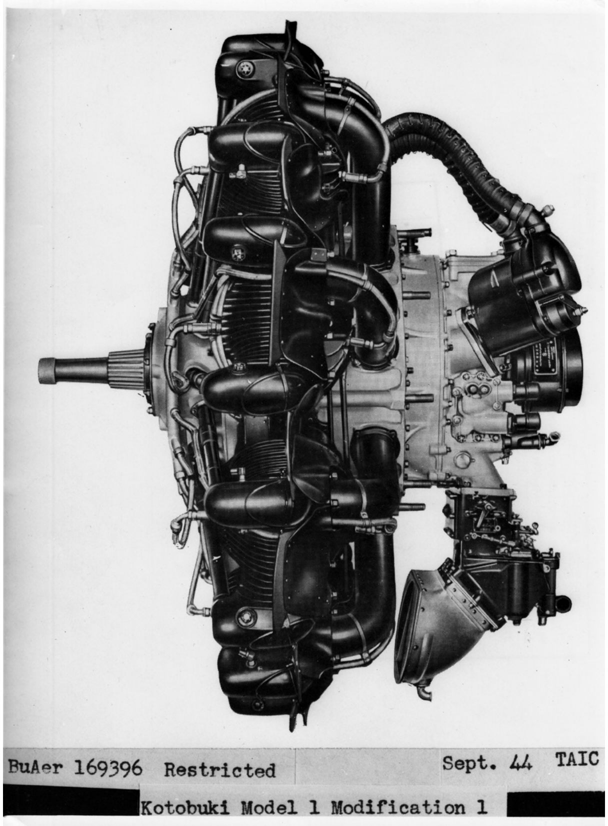
While trying to decide what college to attend, that passion for aviation was reawakened. Jiro's older brother had befriended an assistant professor at the Department of Aeronautics at the University of Tokyo, and invited Jiro to visit the campus with him. Jiro later attended the University of Tokyo's newly established Aviation Laboratory in April 1923, and graduated in 1927 with a degree in Engineering. After college he took a job with Mitsubishi Heavy Industries' aircraft manufacturing plant in Nagoya. Although best known for leading the team that built the Zero, Horikoshi was responsible for other notable designs, to include the A5M (Claude) carrier-fighter and the J2M Raiden interceptor. In the late 1950s, Horikoshi took part in a design team that built Japan's first postwar indigenous aircraft, the NAMC (Nihon Aircraft Manufacturing Corporation) YS-11, a twin turbo prop passenger aircraft. The YS-11 was a joint venture between Fuji, Kawasaki, and Mitsubishi Heavy Industries. Although the YS-11 had limited sales (with only 183 produced), the aircraft was key to revitalizing the Japanese aviation industry. Horikoshi retired from Mitsubishi in 1963. He authored and co-authored a number of books, including *Reisen*, *Eagles of Mitsubishi*, and *From Birth to Glory*, and lectured at the University of Tokyo's Institute of Space and Aeronautics. He became a professor at the National Defense Academy, and later at Nihon University in Tokyo. Jiro Horikoshi passed away in Tokyo on January 11, 1982 following a bout of pneumonia.

were ineffective at high speeds. It lacked several defensive features, such as self-sealing fuel tanks and armor protection (many Allied fighters built around the same time period as the original A6M2 also lacked these features). These deficiencies mattered little at the start of the war, when veteran Japanese pilots overwhelmed inexperienced Allied pilots. By mid-1943, the situation had reversed. The battle for air superiority shifted in favor of the Allies in experience, tactics, and equipment. The Allies developed new team and energy tactics that challenged the Zero's early dominance against first-generation fighters. They also introduced new fighters into the theater like the F4U Corsair and F6F Hellcat that surpassed the Zero's performance in many respects.

Not expecting to fight a prolonged war with the West, the IJN failed to adequately address its insufficient pilot training and lack of development of second-generation fighters, especially in engine development. Newer Japanese fighter designs like the Mitsubishi Raiden and Kawanishi Shiden were never produced in sufficient numbers (due to Japan's limited resources and limited rate of production) to fully replace the aging Zero and were hampered with developmental problems. Mitsubishi's proposed successor to the Zero, designed by Horikoshi, the A7M Reppu, suffered from many of the same setbacks. Zeros therefore remained in production until the end of the war, with nearly 11,000 being produced. Most late-model variants of the Zero were merely stopgap measures, with some late-model versions being less capable in performance than earlier production models. This was in vast contrast to Allied aircraft like the Vought F4U Corsair and the Republic P-47 Thunderbolt, where late-model variants were far superior to the original models. By the end of the war, Zeros (nearly unchanged in overall design since 1940) were still serving on the frontlines operating as interceptors, fighter-bombers, and suicide aircraft.

DESIGN AND DEVELOPMENT

7-*Shi* prototype (1MF10)



A Nakajima Kotobuki 2 Kai air-cooled nine-cylinder radial engine used to power the A5M1. (NARA)

Jiro Horikoshi designed aircraft components for Mitsubishi prior to working on his first airframe design. He traveled extensively to study aircraft designs in Germany, France, England, and the United States. After five years with the company, he rose to chief designer on the IJN's 7-*Shi* (1932) experimental carrier-fighter project. He was surprised at the promotion, and believed Mitsubishi's leadership chose him particularly because he lacked experience and would ignore conventional building techniques and designs.

Horikoshi did exactly that; he broke with tradition and selected to build a cantilevered monoplane, a first for Japan, designated by Mitsubishi as the 1MF10. He envisioned an all-metal aircraft, but Mitsubishi's manufacturing section believed it would be too difficult to construct. Instead, the 1MF10 utilized duralumin semi-monocoque fuselage and wing structure (the wings were covered in fabric). Horikoshi utilized a duralumin box spar to join the wings, a feature found on some of his later designs. Another compromise was the 1MF10's cockpit. It was not streamlined with the body, but was raised for better visibility over its 780hp Mitsubishi A4 twin row radial engine.

The company faced time constraints and built two examples, the first assembled in March 1933. Horikoshi was underwhelmed with his final product. The aircraft had abundant drag penalties (raised cockpit, thick wings, and fixed landing gear with wide wheel fairings) and performed poorly as a fighter. On July 1933, the first prototype's vertical stabilizer failed during a dive test. Fortunately, the Mitsubishi test pilot bailed out successfully. The second, revised, prototype crashed a month later during testing by the IJN's Yokosuka Air Corps. The pilot survived this accident as well. Mitsubishi's bid for the 7-*Shi* carrier-fighter failed, although the lessons learned in attempting to build such an advanced machine paid off in their future projects.

Japanese carrier-fighter development

Designation	Lead Design Company	Years of Service (IJNAF)
1MF	Mitsubishi	1923–30
A1N	Nakajima	1929–35
A2N	Nakajima	1932–36
A3N	Nakajima	1936–39
A4N	Nakajima	1936–40
A5M	Mitsubishi	1936–45
A6M	Mitsubishi	1940–45
A7M	Mitsubishi	N/A

9-*Shi* prototype (Ka-14)

In February 1934, Lt Cmdr Hideo Sawai of the Naval Aviation Headquarters released requirements for a new fighter to replace the Nakajima A4N. Both Mitsubishi and Nakajima submitted monoplane designs for the new fighter. The specifications required an excellent climb rate (16,400ft in 6.5 minutes) and a top speed of 220mph, as well as excellent maneuverability. The Japanese doctrine of preemptive strike required new aircraft to conduct much more than fleet defense; it needed to oppose enemy fighters and provide escort for friendly bombers. The IJN later eased some of the range requirements, and the ability to operate from a carrier was deliberately not specified. The aircraft's dimensions still had to meet with the size constraints of a typical carrier's flight deck elevator.

Mitsubishi entrusted Horikoshi a second time and made him the lead designer on the project. Horikoshi assembled his team and discussed building another low-wing monoplane with fixed gear, similar to the 1MF10. This prototype would be a completely different aircraft and with the requirements eased, Horikoshi felt less constraints were placed on this new design. He chose a Kotobuki Type 5 single row radial engine produced by Nakajima. The engine produced 550hp and was lightweight compared to engines built by Mitsubishi. Figuring Nakajima would utilize the same engine, Horikoshi wished to make the competition strictly a battle between airframes.

Japanese engines were still underpowered in comparison to Western-made engines. For optimal gain from these powerplants, weight saving was a priority. Both companies utilized a low-wing monoplane design, but Nakajima used fabric-covered wings, while Horikoshi designed a slender all-metal airframe made from duralumin and a metal wing with reduced thickness. The first prototype designated the Ka-14 by Mitsubishi used an inverted gull wing design with no flaps. The team utilized flushed rivets and the fixed landing gear was fitted with streamlined wheel fairings to reduce parasitic drag on the airframe. The design team considered using retractable gear, but decided that the drag penalty of the fixed gear was minor in comparison to the weight added by using retractable gear.

The prototype weighed less than the team's original estimate. As the aircraft's skin was noticeably uneven due to the team's inexperience with flushed riveting, the team smoothed out the dimples utilizing small amounts of putty. Finally, the aircraft was painted ash green. The design team moved the first prototype to Kakamigahara Airfield for its first test flight on February 4, 1935. Horikoshi's prototype recorded phenomenal air speeds, exceeding 273mph. Although the climb rate and maximum speed were significantly better than required, the overall maneuverability of the aircraft fell short of expectations.

The second prototype disposed of the gull wing design and incorporated a straight wing with split flaps to improve the prototype's landing characteristics (split flaps also improved maneuverability during dogfights). The wings of the second prototype incorporated a washout at the ends of the leading edges to reduce tip stall, and the engine was replaced with a Kotobuki 3, with improved horsepower. The Mitsubishi Ka-14 prototype was faster than the Japanese Army's Ki-10 experimental fighter, which used a 950hp engine. In late 1935, Lt Minoru Genda's Yokosuka Naval Air Corps flew the prototype in mock dogfights against a variety of aircraft including Dewoitines D.510, Hawker Nimrod, Heinkel He 112, Seversky 2PA, Kawasaki's Ki-10 fighter, and the

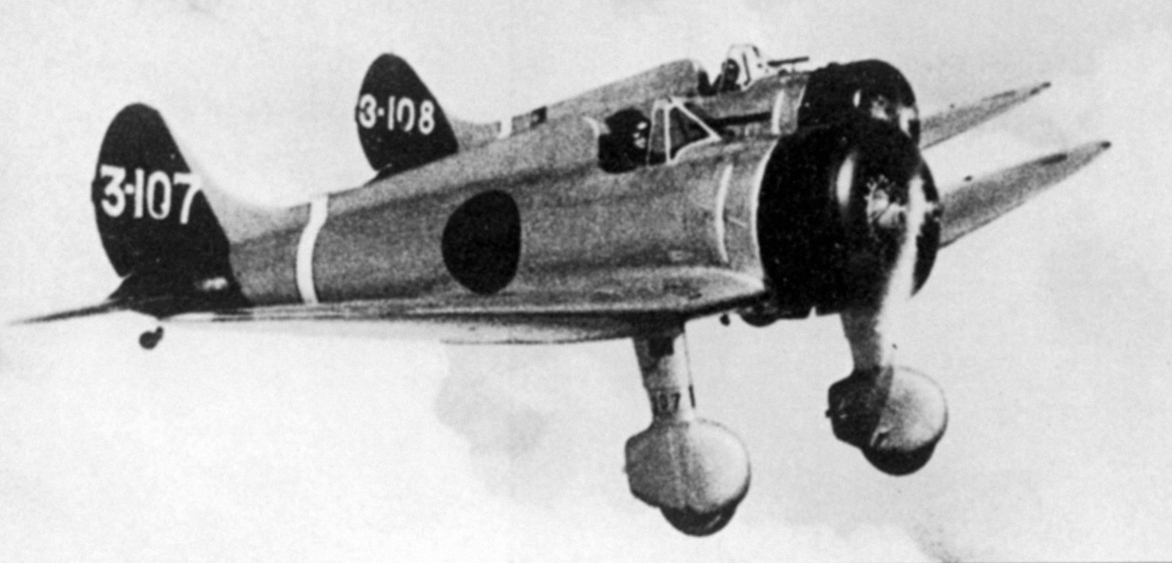
Nakajima A4N carrier-fighter. Only the Ki-10 was more maneuverable, yet the new prototype could successfully engage this fighter in the vertical plane. In all, six prototypes were created utilizing various powerplants. Ultimately, the Mitsubishi design was selected over the Nakajima prototype and the aircraft went into production as the Type 96 (A5M1). The name "Type 96" is derived from the Japanese calendar year 2596 (1936), the year the aircraft went into service.

A5M Type 96: the Zero's direct predecessor

The first production model, the A5M1, was powered by a Nakajima Kotobuki 2 KAI 1 nine-cylinder air-cooled radial engine producing 630hp at 5,000ft. The fighter was armed with two 7.7mm Type 89 machine guns (500 rounds each) located discreetly in the nose, with muzzle exits located at the front/top on the engine cowl. Carrier equipment was limited to an arresting hook forward of the tail wheel; the wings of the A5M1 required no folding mechanism due to their small size. The wings also incorporated twist down (washout) leading edges towards the wing tips to prevent tip stall. One A5M1 was used as a testbed and had two 20mm Oerlikon FF cannons installed in the wings (one each), and was designated A5M1a.

The A5M1 was followed by the A5M2a, which utilized a more powerful Nakajima Kotobuki 2 KAI 3A powerplant producing 690hp at 13,000ft. Some significant improvements were introduced with the A5M2b variant as a result of lessons learned in combat over China. The A5M2b utilized a NACA-designed cowling (with cowl flaps) streamlining the aircraft and improving forward visibility. The A5M2b was powered by a Nakajima Kotobuki 3 engine producing 715hp at 9,000ft, and featured a three-bladed propeller and an enclosed cockpit with a larger fuselage cross-section. The A5M2b could carry two 30kg bombs, one under each wing. The A5M2b's enclosed cockpit had mixed reviews as it hindered visibility, and was often removed in the field and later during production.

Mitsubishi built two A5M3s featuring a 12Xcrs Hispano-Suiza, 12-cylinder liquid-cooled engine (producing 690hp at 13,000ft), and a single 20mm cannon firing through the propeller hub. The type never entered production.



A pair of Mitsubishi Type 96 carrier fighters of the 12th Kokutai flying in formation over China during the Second Sino-Japanese War, 1939. The A5M2b in the foreground (3-107) was used by Saburo Sakai to score his first kill, a Russian-built I-16, on May 22, 1938, over Hankow, China. (IJN)

The most numerous variant built was the A5M4 (Model 24). This variant, based on the A5M2b, utilized an improved Kotobuki 41 engine. This was followed by the A5M4 (Model 34), which utilized a Kotobuki 41 KAI engine. The last variant produced was a two-seat trainer version (designated the A5M4-K) built by the 21st Naval Air Arsenal. The trainer was powered by a Kotobuki 41 engine and featured a tandem open cockpit layout with an anti-roll bar between the student and instructor.

The Type 96 was the world's first operational carrier-based monoplane fighter. Introduction of the Mitsubishi A5M2 could not have come at a more crucial time, as older Japanese fighters deployed to the Second Sino-Japanese War had lost their edge. The Chinese Nationalist Air Force employed a range of fighter aircraft that included Curtiss Hawk IIIs, Polikarpov I-152 biplanes, and two types of monoplane fighter – the American-built Boeing P-26 (Model 281) Peashooter and the Russian-built Polikarpov I-16. The new Mitsubishi fighter began replacing the A2N on the IJN carrier *Kaga*, and flew the first combat mission for the type on August 22, 1937, but encountered no aerial opposition. This changed on September 4, 1937, when two A5M2s claimed three Curtiss Hawk biplanes with no loss of their own. On September 19, 1937, monoplane fighters of mostly metal designs fought in air-to-air combat for the first time when A5M2s clashed with Boeing Model 281s (P-26 Peashooters). A dozen A5Ms from the 13th Kokutai departed Zhenru Airfield in Shanghai (a forward airbase) to escort Mitsubishi G3M (Nell) bombers and Nakajima E8N reconnaissance seaplanes for a mission over Nanking. The IJN pilots from the 13th Kokutai claimed 15 enemy fighters without a loss of their own. The victories were attributed to the speed and climb rate of the A5M2, combined with new tactics like the *hineri-komi* maneuver.

The Type 96 carrier-fighter continued to dominate the skies over China, operating from both carriers and land bases. To counter Japan's air superiority the Chinese began to relocate their air power further inland, out of reach of the IJN fighters. This left Mitsubishi G3M medium bombers vulnerable to attack as the A5Ms lacked sufficient range to provide escort. The Type 96 had other shortcomings that were brought out during combat. With only two rifle-caliber machine guns, it was difficult to bring down Russian-built I-16s, which also had a speed advantage over the Type 96. Early variants of the A5M had no air-to-air communication, and later variants that incorporated radios often had them removed to improve flight performance. Regardless, many of the IJN's top aces of World War II gained their early combat experience piloting the Type 96. The A5M would remain in the IJN inventory until the end of World War II. The last major combat for the type took place on May 7, 1942, during the battle of the Coral Sea. Towards the end of the war some Type 96s were utilized as kamikaze aircraft.

12-*Shi* prototype requirements

The Imperial Japanese Naval Air Arm challenged the limits of their country's aviation industry when they drafted the requirements for their new 12-*Shi* carrier-fighter. Lt Cmdr Hideo Sawai, who had prepared the requirements that led to the creation of the A5M, submitted planning requirements to both Mitsubishi and Nakajima on October 5, 1937. The requirements were revised from the standards established five months earlier due to lessons learned from operations in China during the Second Sino-Japanese War. The aircraft had to have a wingspan of less than 12m in length. It needed to reach a maximum speed

The first flying prototype "Unit-1" under construction at Mitsubishi's prototype plant in Nagoya. A second prototype, "Unit 2," can be seen in the background. (IJN)

of 310mph in level flight at 13,000ft, with the maneuverability present in the A5M. Armament called for two 7.7mm machine guns and two additional 20mm cannons. Communication equipment included a radio and a direction-finder. The IJN specified a range of 1,110 miles (1,870km) or 1,685 miles (3,110km) with a drop tank. The fighter needed to climb to 9,800ft in 3.5 minutes. The requirements for carrier operations included a landing speed of less than 67mph, and the ability to take off in less than 230ft with a 30mph headwind.

The 12-*Shi* requirements seemed to be an engineering impossibility, and Horikoshi considered it an aviator's selfish wish list. After coming to the conclusion that the requirements were too stringent, Nakajima dropped out of the competition. Mitsubishi, however, employed an engineer known for making the impossible happen. If Horikoshi's non-traditional thinking could produce a plane to the IJN's requirements, the Japanese would have a fighter far superior to anything in the West. In early 1938, at a joint conference between industry officials and the government, Horikoshi asked the government to revise their requirements. The officials attending, one of whom was Lt Cmdr Minoru Genda himself, answered simply, "No, we can't withdraw anything."

As with the A5M, the first obstacle to tackle was selecting a powerplant. The available choices were both Mitsubishi engines – the Kinsei Type 46 and the Zuisei Type 13. The Kinsei Type 46 was more powerful but required a larger airframe to support it and was less fuel-efficient. In the end Horikoshi selected the less powerful Zuisei powerplant to keep the size and weight of the airframe down. A two-bladed constant-speed propeller from Hamilton Standard (license-built by Sumitomo) was selected. According to Horikoshi, the airframe would be a more streamlined version of the A5M, with the body following the contours of the engine cowl. To reduce parasitic drag, a retractable undercarriage was incorporated into the design. The wings would differ from the A5M's elliptical style; instead, the prototype would have straight tapered wings with narrow tips, and a horizontal stabilizer designed to match the wing's shape. The airfoil used was the Mitsubishi 118, similar to the unit on the A5M. Instead of attaching each wing to the fuselage, Horikoshi designed the A6M1's wing as one piece integral with the fuselage, which strengthened the overall wing design and saved weight by eliminating heavy wing attachment fittings. There were drawbacks: designing the wing in such a manner made it more time-consuming to produce.

Horikoshi understood that meeting the IJN's high expectations required a drastic change to how standard fighters were designed. He chose an intensive weight reduction program that challenged established worldwide safety factors. Having started his career at the company designing aircraft components, Horikoshi had observed multiple structural tests to understand the forces placed on individual parts and how they failed. He also understood that some parts would have inherent strength in their design and therefore could be made from different material to lighten the aircraft. The next breakthrough came from Sumitomo Metals of Osaka who had been experimenting with a new type of metal alloy called "Extra Super Duralumin" or ESD. This was a zinc–aluminum alloy that was lighter and stronger than copper-based alloys.

The IJN's range, armament, and maneuverability requirements made building the appropriate wing for the new fighter a challenge. Making matters worse, the wingspan needed to be short enough to fit on a standard aircraft carrier elevator. Once the airfoil (Model 118), retractable main landing gear, and cannons were selected, the process progressed further. Horikoshi decided to go with the largest wing area and wingspan possible. This allowed for greater maneuverability in a dogfight as well as good carrier landing and takeoff characteristics. The large wing had its drawbacks. The drag penalty would lower the aircraft's maximum level flight and diving speeds. The wing's leading edge twisted slightly down at the tips (washout) to avoid tip stall, barely noticeable to the naked eye. This feature had been used on the A5M to improve dogfighting performance.

The team created a wooden mockup of the prototype at the Mitsubishi plant in Nagoya. An inspection of the model was held on April 27, 1938. Imperial Japanese Navy Air Force (IJNAF) pilots examined it for over two hours and came up with a list of suggested improvements. With the full-scale mockup inspection over, the team went to work on creating the first prototype. The first step was to install the jigs to create the subassemblies. The prototype had three main subassemblies: the wing/center fuselage, forward fuselage, and aft fuselage.

12-*Shi* prototype (A6M1)

12-Shi prototype design chiefs	
Chief Design Engineer	Jiro Horikoshi
Structures & Computing	Yoshitoshi Sone
Propulsion	Den-ichiro Inoue
Armament	Yoshimi Hatakenaka
Undercarriage/ Landing Gear	Sadahiko Kato

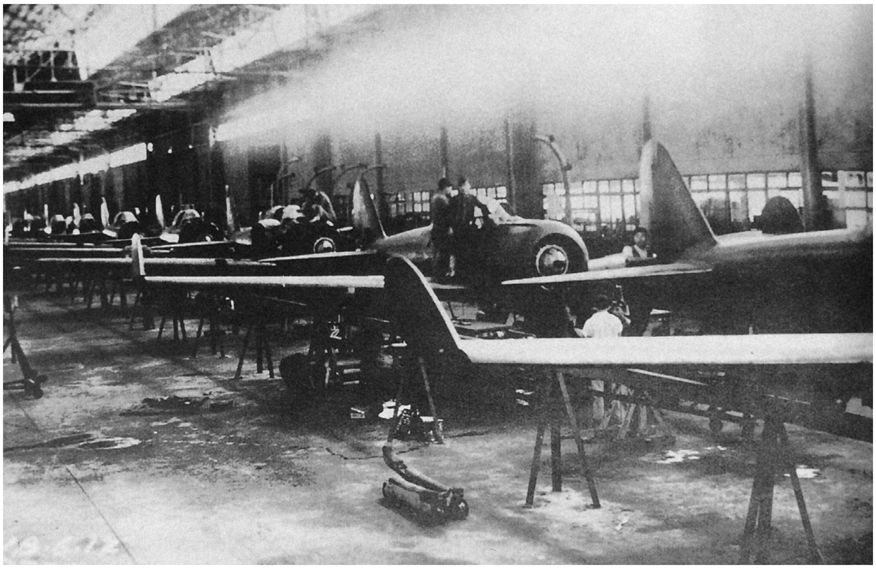
The first prototype to be assembled at Mitsubishi's prototype plant was used for structural tests. The aircraft was turned over to the Naval Aeronautical Establishment for destructive testing. The results proved Horikoshi's theory that drastic weight reduction and lowering the uniform safety factors on certain parts would not hamper the aircraft's overall strength. On March 17, 1939, Mitsubishi's team held a completion inspection of the first flying prototype at their Nagoya factory. The IJN was on hand to inspect the aircraft and confirmed the weight, center of gravity (CG), and overall dimensions of the prototype. The prototype weighed 1,565.9kg, only 31.8kg over Horikoshi's original projections. Approximately 55kg of excess weight came from design components he could not control (engine and propeller weight). The airframe was painted ash green with a black engine cowling. Shortly thereafter, a second flying prototype was finished.

The main visual difference between the prototypes and later production aircraft was a two-bladed propeller with no spinner. The first flying prototype utilized the Mitsubishi-built Zuisei 13 radial engine, with 14 cylinders in two rows rated at 780hp, at 2,540rpm. The engine's carburetor air intake was placed on top of the cowling with the oil cooler on the bottom. Both prototypes used license-built Hamilton Standard constant-speed propellers (manufactured by Sumitomo) with two metal blades. Jiro Horikoshi's team decided to change the two-bladed propeller to a three-bladed type after excessive vibration during early test flights. The empennage of the two prototypes differed significantly from production aircraft. The tail section was slimmer and the horizontal stabilizer was initially situated level with the fuselage's centerline. The vertical stabilizer and rudder were also redesigned on production aircraft. Armament consisted of two 7.7mm machine guns firing out of gun ports located in the nose cowling, two Type 99 Mark 1 20mm cannons (one in each wing), and fixtures for two 60kg bombs.

Testing

The first flying prototype was disassembled and transported to Kakamigahara Airfield on ox carts. After reassembly, the aircraft was inspected and went through some preliminary tests. The maiden flight of the prototype Zero took place on April 1, 1940. The weather for the first flight test, with light winds, was perfect. Kakamigahara Airfield, located in Gifu City, was operated by the Imperial Japanese Army Air Force (IJAAF); as such, the tests waited until Army training had been completed for the day. The aircraft was then rolled out of the hangar and readied for its first flight.

The lead test pilot, Katsumo Shima, a former IJN aviator, was chosen to make the first flight. After looking over the gauges and checking the control surfaces, he raised his hand to signal to the staff that he was ready. Shima first commenced ground tests and requested that the brakes be adjusted for better response. Once the ground tests were completed, he conducted a jump flight, lifting the aircraft off the runway for a matter of seconds and then landing. At 1730hrs the A6M1 took flight. The pilot next conducted a series of low-speed



Model 21s nearing completion at the Nakajima plant, Ota. By the end of the war, Nakajima had produced nearly twice the number of Zeros built by Mitsubishi. (IJN) tests with the gear extended. Katsumo Shima and Harumi Aratani reported that the aircraft handled similarly to the A5M, but both pilots experienced severe vibration when the aircraft was put into a climb and when the engine was at idle. The team concluded that the vibration was caused by resonance and partially solved the problem in mid-April by replacing the two-bladed propeller with a three-bladed unit (after all attempts to lower the vibration levels while using the two-bladed constant-speed propeller failed). Additionally, engine supports with rubber dampers aided in lowering the vibration levels.

Flight tests continued throughout the month, with stability control and performance tests scheduled for April 25. Issues arose with the elevator's excessive responsiveness at high speeds prior to the scheduled control tests, a problem that would not be solved prior to the performance tests. During these performance tests, the Prototype 12 recorded a speed of 490km/h (304mph); this number was later adjusted to 508km/h (315mph), besting the speed requirement established by the IJN. At the beginning of May, Horikoshi traveled to Tokyo to report on the tests, impressing members of the Naval Aeronautical Establishment. Two major items of interest came from the May 1 meeting: first, the IJN allowed Mitsubishi to utilize the Nakajima Sakae-12 engine for the production model (the IJN designated the Sakae-powered aircraft the A6M2). Second, the IJN chose to allow Mitsubishi to finish the performance tests on their own, knowing that some elevator control issues still existed with the aircraft.

Excessive elevator response during high-speed maneuvers was common for aircraft of that time. With the A6M1, the problem increased as the aircraft achieved speeds well above the norm of the day. To solve the issue, Horikoshi once again went against industry standards. He looked at reducing the rigidity of the control cables themselves, a violation of regulations that specified control cable size. By using smaller control cable diameters, the rigidness in the controls was similar at low speeds, but reduced dramatically at high speeds as the smaller cable would stretch. Horikoshi later termed this "Improvement of Control Response by the Method of Reduced Stiffness."

An accident occurred with the second flying prototype during operational tests on March 11, 1940, killing Masumi Okuyama, a test pilot from the Naval Aeronautical Establishment's Flight Test Division. The test was to investigate issues stemming from the constant-speed propeller, specifically the variable speed controls. Witnesses reported hearing a loud bang and seeing the aircraft disintegrate while in a dive. Although Okuyama managed to bail out and open his parachute, investigators believed he was only semi-conscious as he detached his parachute early, at a height of nearly 1,000ft, falling to his death. When word of the accident reached Mitsubishi, Horikoshi immediately left Nagoya for Yokosuka. The investigators first suspected flutter but then turned to the constant-speed propeller, since the engine had separated from the airframe in flight, and because of the positions of the blades in the wreckage. A second

A

1. Mitsubishi Works A6M1 Prototype, Kakamigahara Airfield, Gifu City, Japan, April 1940.
2. Mitsubishi Works A6M2 Model 11 (3-141), 12th Kokutai, Lt Minoru Suzuki, China, May 1941.
3. Mitsubishi Works A6M2 Model 21 (AI-155), Lt Cmdr Shigeru Itaya, *Akagi*, December 7, 1941.
4. Nakajima Works A6M2-N Type 2 Float-Fighter (YII-105), assigned to IJN seaplane carrier *Kamikawa-Maru*, August 1942.

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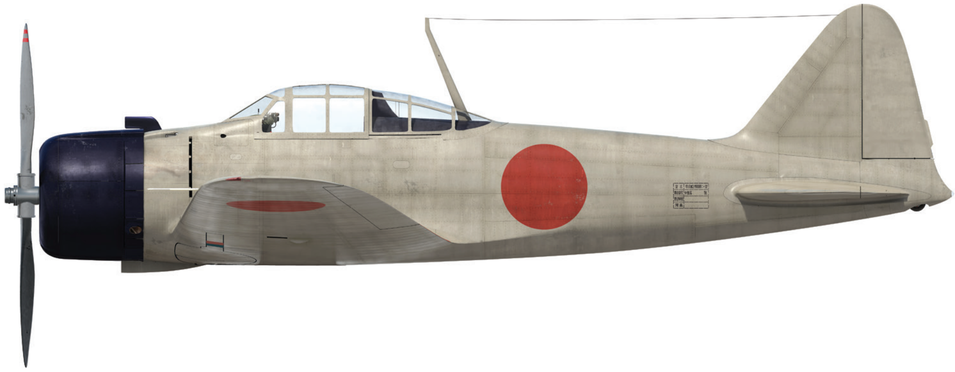

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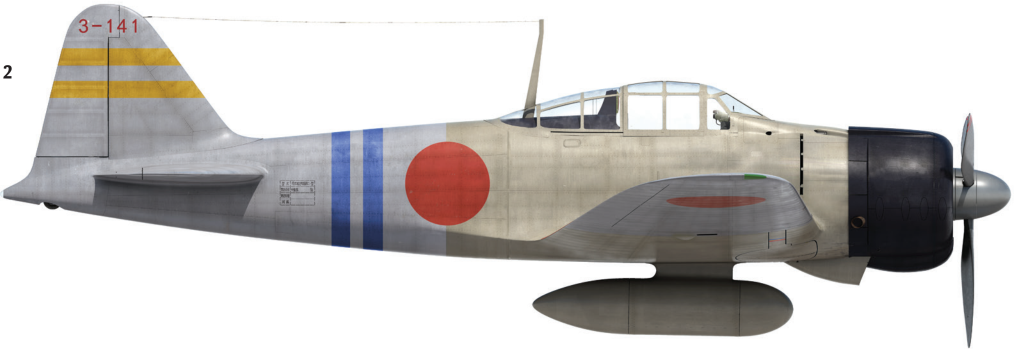

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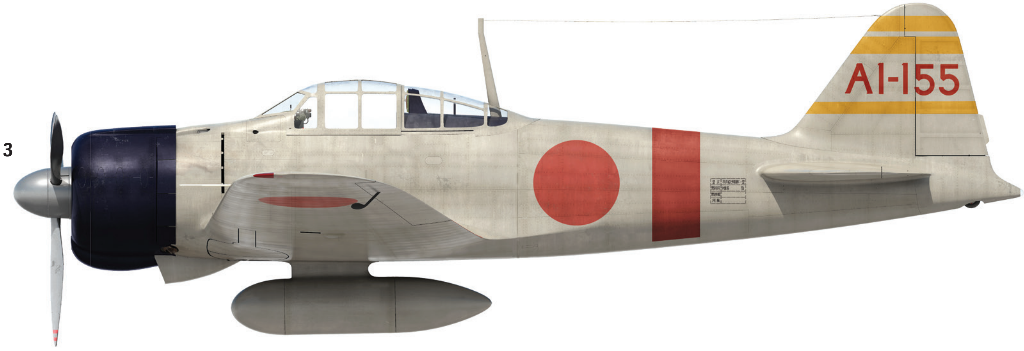

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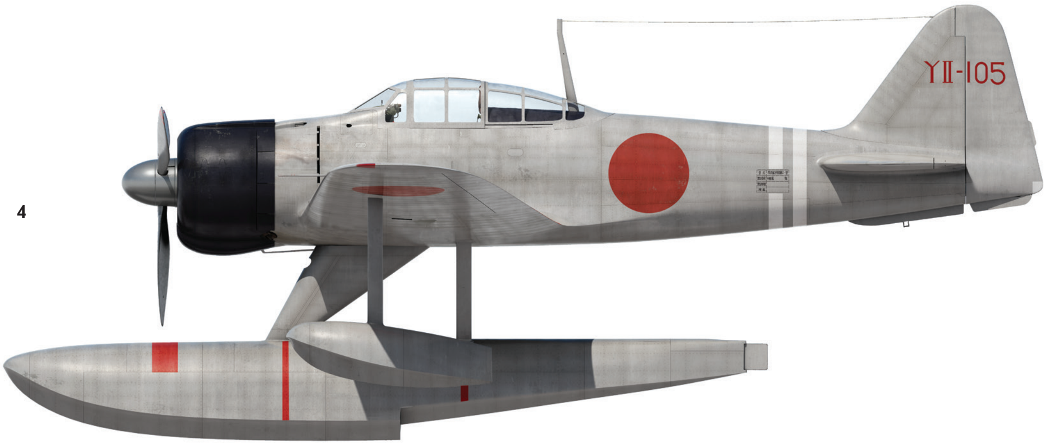


possibility was an in-flight detachment of the elevator's mass balance weight, creating flutter with the aircraft's elevators and causing disintegration of the aircraft. The plane's mass balance weight was missing from the accident scene.

Ultimately, the IJN's investigation team blamed the elevator mass balance. Mitsubishi accepted the IJN's report and redesigned and strengthened the elevator mass balance. The company also fixed ongoing issues with the constant-speed propeller. In total, Mitsubishi's team of test pilots, engineers, and maintainers executed and supported 119 flight tests, and another 215 ground tests within a five-month period. With the vibration and elevator control issues solved, the Prototype 12 was readied for operational testing by the IJN.

Various weapons tests were conducted to verify that the two 20mm cannons (one in each wing) and the two 7.7mm machine guns housed in the nose operated effectively at different altitudes. Some issues did arise during the IJN's operational tests with the drop tank releasing and with the engine vapor locking at altitude. The latter was solved by utilizing a different type of fuel. The drop tank issue would remain a problem even in later production aircraft. The IJN officially accepted the A6M1 in July 1940. The letter A stood for carrier-fighter, the numeral 6 indicated that this was the sixth carrier-fighter ordered by the IJN, the letter M signified the manufacturer (Mitsubishi), and the numeral 1 denoted the first model. At the end of July the 12-*Shi* was officially accepted by the IJN and given the name Type Zero Carrier-Based Fighter. The name Type 00 (or Zero for short) comes from the Japanese tradition of utilizing the last two digits of the year it was officially accepted: in this case 1940, which was the Japanese year 2600.

Pre-Production

The third through fifth aircraft off the line at Nagoya incorporated redesigns to the aft fuselage section and empennage. The aft fuselage was now wider and longer than on the prototype. The empennage included a redesigned vertical stabilizer and rudder, along with the horizontal stabilizer's higher placement on the aft fuselage. These new design elements remained on all later-production A6Ms. The biggest visual differences between early Model 11s and late models were the positions of the oil cooler and carburetor intakes. The new Nakajima Sakae-12 engine required the oil cooler and carburetor inlets to be moved to the bottom of the fuselage. The first three aircraft utilized a single intake opening for the oil cooler and carburetor. A horizontal splitter plate separated the air flow. This design was changed, starting with the sixth aircraft, so that the carburetor air intake and oil cooler intake had separate intake openings in tandem. The carburetor air intake was relocated at the front of the cowl (lower side) with the initial design having a slightly pinched opening; this was later changed for a wider opening. The oil cooler air intake was relocated toward the rear of the cowling, with its opening starting near the cowl flaps. In May, the IJN notified Mitsubishi that the Zero fighter would be sent to the front as an experiment. Early production Model 11s, along with whatever spare parts could be manufactured, were in theater by June 1940.

Powerplants

At the start, Horikoshi wanted to utilize a Mitsubishi powerplant instead of a competitor's engine. Both flying prototypes used the Mitsubishi-built Zuisei 13 radial engine, with 14 cylinders in two rows rated at 780hp at 2,540rpm, paired with a Hamilton Standard constant-speed propeller license-built by Sumitomo. The Mitsubishi engines were underpowered and less reliable than the Nakajima Sakae-12, so when the IJN permitted the use of the Nakajima powerplant, Horikoshi switched. The Nakajima Sakae-12 was an air-cooled radial engine design with 14 cylinders arranged in two rows. The powerplant utilized a CS40B three-bladed constant-speed propeller manufactured by Sumitomo/Hamilton, and produced 940hp at 2,550rpm. The Sakae-12 engine was used on the A6M2a and A6M2b aircraft. Both the A6M2-N Type 2 float-fighter and the A6M2-K two-seat trainer also utilized the original Sakae-12 engine.

The first engine upgrade came with the introduction of the A6M3 (Model 32). The new model utilized a Nakajima Sakae-21 engine. The Sakae-21 was also an air-cooled radial with 14 cylinders in a double row, producing 1,130hp at 2,750rpm. The new engine also incorporated a two-speed supercharger for better high-altitude performance. The powerplant had a down-flow carburetor and a redesigned cowling to incorporate the air intake at the top/center of the engine cowling. A horizontal splitter plate was added to the oil-cooler air intake. The new engine was used on the Model 32, Model 22, and Model 52. The Sakae-21 remained the predominant powerplant for the Zero until the end of the war.

Some slight changes were made to the engine after the A6M5 (Model 52) was introduced. The most noticeable visual difference was that individual exhaust pipes replaced the older grouped exhaust pipes on each side. This allowed additional thrust to be generated by the engine exhaust, but required a redesign of the cowl flaps and additional heat shielding for the fuselage. The front of the engine cowling was also slightly revised. Late-production A6M5as saw the addition of a new propeller shaft, counterweight, and longer spinner. A water methanol injected version of the Sakae-21 named the Sakae-31a was developed for use on the A6M5 Model 52-*Hei* and future variants/models. The Sakae-31a water methanol injected engine was fitted to a single prototype named the A6M6c, but the project faltered and the Model 52 went into combat with the Sakae-21 powerplant. The water methanol injection system would have boosted the power by only 100hp in short bursts had the system worked. The A6M7 Model 63 used a Sakae-31 without the troubled water methanol injection system. The engine produced 1,130hp, the same as the Sakae-21.

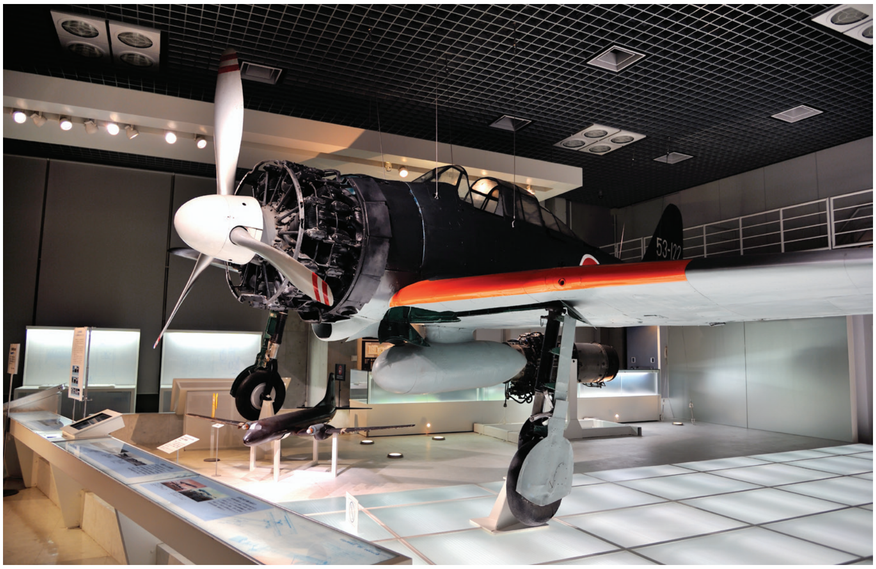
The most powerful engine ever fitted to a Zero was a Mitsubishi design, the Kinsei-62. Not since the original flying prototypes had a Mitsubishi powerplant been used on a Zero. The Mitsubishi Kinsei-62 was an air-cooled radial design with 14 cylinders in two rows, producing 1,560hp. The engine was used to power the Yokosuka D4Y3 (Judy) dive bomber. The diameter of the engine was considerably larger than the Sakae powerplants. The nose armament was deleted due to the new engine and the cowling was redesigned and thickened. Only two prototypes were built, and although production was initiated, no production aircraft made it off the assembly lines.

Subassemblies

Wings and undercarriage

Of the Zero's three main subassemblies (wing/center fuselage, forward fuselage, and aft fuselage), the wing was the most time-consuming for Horikoshi's team of engineers to develop. The IJN requirement limited the wing to 12m. The aircraft also needed to take off in a distance of 230ft with a 40fps headwind (both requirements were due to conditions related to carrier

A Nakajima Works A6M2 Zero with its engine cowling removed at the National Science Museum in Tokyo, 2011. This aircraft was converted into a two-seater for reconnaissance purposes in the field at Rabaul. This Zero ditched in the waters near Cape Lambert, Papua New Guinea, on January 9, 1945, and was recovered in 1972. (Akira Uekawa)



operations). The aircraft needed to be capable of executing long-range escort missions that required both wings to hold large fuel cells. On top of this, the aircraft still needed to maneuver as well as the Type 96 carrier-fighter, be capable of climbing to 10,000ft in less than 3.5 minutes, and have a maximum speed of over 310mph.

The wing's basic structure remained similar throughout production, with only slight modifications. The Zero utilized a semi-monocoque wing with two main wing spars with 50 ribs (25 in each of the starboard and port wings). The wing's skin was made of duralumin and both wings were constructed as one piece integral with the cockpit. The Model 11 Zeros had a wingspan of 12m, the maximum allowed by the IJN, with a wing area of 22.4m^2. Each wing carried a single drum-fed 20mm cannon and a 190-liter fuel cell. Like most fighters of the time, the wing fuel cells were not self-sealing. The wing was designed to carry a 320-liter drop tank on the centerline. The first redesign of the wing appeared with the introduction of the Model 21, or A6M2b. Tests proved that the 12m wingspan of the Model 11 was still too large for practical carrier operations. Starting with the 65th aircraft, the Zero's wing was redesigned to have upward-folding wing tips (50cm) for better clearance while using the carrier's elevators. During production, aileron balance tabs were added to each aileron, starting with the 127th aircraft built.

A major redesign of the wing started with the A6M3 Model 32. The new model had a smaller wingspan with squared-off wing tips. The wing folding mechanisms were eliminated and the ailerons were shortened. The new wing spanned 11m and gave the aircraft better roll rates. Each wing housed a single drum-fed 20mm gun (100 rounds) and a fuel cell capable of holding 220 liters. Pilots disliked the Model 32, as it lacked the maneuverability of the Model 21. It also lacked the range of the earlier model due to its more powerful engine. Only 343 A6M3 Model 32s were produced.

The older-style wing was brought back into production for the Model 22, with the addition of a 45-liter fuel cell in each outer wing and manual folding wing tips. Also, the aileron balance tabs were eliminated during the production run (of which 217 were built). The 20mm armament was changed during production to a Type 99 Mark 2, the cannon's barrel extending out of each wing.

With the introduction of the Model 52 or A6M5, the wings were shortened a second time to 11m to help increase speed. The wing kept its rounded shape, but the wing tip folding mechanisms were eliminated. Additionally, the ailerons on the A6M5 were extended to the wing tips. An automatic fire extinguisher was added to the wing fuel cells.

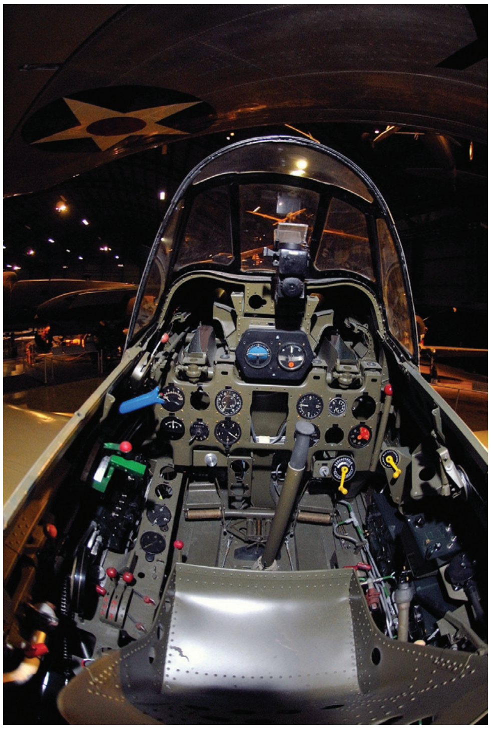
The next change in the Model 52 series came with the introduction of the Model 52-*Koh* or A6M5a. The wing received a thicker skin to increase dive speed and incorporated a 20mm Type 99 Mark 2 Model 4 with a belt-fed system (125 rounds). The A6M5b was capable of carrying a 150-liter external fuel tank on each wing and a 300-liter wooden centerline tank. The A6M5c variant saw an increase in armament; each wing featured a 20mm cannon and a 13mm machine gun (requiring a revision to the outer wing panels). Furthermore, a new bomb rack was devised for carrying two bombs on each wing, positioned outside of the 13mm machine gun. A new wooden centerline external tank with stabilizing fins that utilized a four-point attachment system was added. The last production variant of the Zero, the A6M7, incorporated a centerline rack capable of carrying an external tank or bomb in a recessed position.

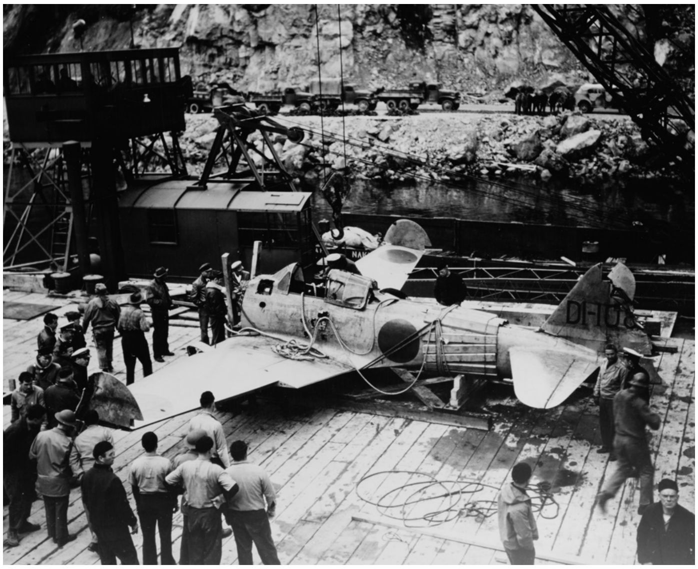
The main gear was raised inward parallel to the wing by hydraulics and were fully enclosed into the wheel wells. The inner wheel covers had a distinct curved shape so as not to interfere with the centerline drop tank. The brakes for the main gear were of traditional design and engaged by rocking the rudder pedals forward. The tail wheel, positioned aft of the arrestor hook, also retracted hydraulically, and could be locked or unlocked from the cockpit. The aircraft had no parking brakes, and needed to be chocked after coming to a complete stop.

Cockpit and fuselage

The cockpit and fuselage of the A6M saw minimal changes throughout the production run. The instrument arrangement was simple and effective. The pilots themselves can take some credit, as naval aviators were brought in to evaluate the cockpit arrangement during the mockup stage. The instrument panel was originally made of metal, but as resources dwindled toward the end of the war, plywood was used. A total of 15 instruments were on the main panel. The center of the main panel held the primary instruments, an artificial horizon, turn gauge, and below them was a radio compass. The air speed indicator and altimeter were located to the left of the radio compass while the vertical speed indicator and oil temperature gauge were to the right. Atop of the instrument panel was the Type 98 reflector gun/bomb sight. The control stick was unusual when compared to Western fighters as it had no trigger mechanism; the trigger and selector switch were located on the left console panel with the throttle controls. The bomb and drop tank release levers were also located on the port console panel aft of the throttle controls. The A6M2 had the Type 96 Mark 1 radio installed on the starboard side of the cockpit. The radio was installed on a shelf aft of the cockpit on the starboard side for A6M3 and later models. The starboard console panel still contained radio equipment, homing device, radio control board, and tuning devices. A wooden

Cockpit view of an A6M2b on display at the National Museum of the United States Air Force, Wright-Patterson AFB, Ohio. Unlike most Western fighters, the control stick had no trigger mechanism to fire the guns or cannons. The trigger and selector switch was placed on the throttle control (blue handle) on the port console. (USAF)





The Akutan Zero with its forward fuselage/powerplant removed seen being readied for transport to NAS San Diego. An earlier example of an A6M2 was captured prior to this aircraft, but the Akutan or Koga Zero was the first to be flight-tested. (NARA)

antenna mast was located on top of the fuselage and exited at the aft section of the canopy. The landing gear and flaps were controlled hydraulically, with the levers for both located on the starboard side.

The Zero's predecessor, the Type 96, had poor rear visibility for an open cockpit aircraft (later versions had a closed canopy, which was disliked by the pilots due to its visibility restrictions). The Zero's canopy design featured a three-piece Plexiglas canopy (front, mid and aft sections) with excellent all-round visibility. The mid-section slid rearward with interior and exterior opening handles. The first use of bullet-resistant glass was adapted with the A6M5b, which utilized a 45mm piece installed in the interior of the front section of the canopy. The A6M5c variant and some A6M7s had bullet-resistant glass on the front windshield and directly behind the pilot's head, incorporated as part of the head rest (most A6M7s had the bullet-resistant glass removed). The aft section had thicker 55mm glass installed.

The pilot's seat was not fixed to the floorboard, but supported by two metal arms attached to a horizontal bar mounted to the fuselage. Because of this arrangement, the seat height could be adjusted mechanically during operation to allow for better visibility on takeoff and landings. A new seat design was introduced late in the war due to changes in parachute design. The rudder pedals could be adjusted to the pilot's preference as well. Aft of the pilot's seat were oxygen bottles, hydraulic oil tank, and a battery.

The weight-saving measures in fuselage design were apparent at first glance. The structural spars of the fuselage and accessory shelving had holes to reduce the overall weight. The A6M2's forward fuselage housed an oil tank and a fuel cell installed in tandem. The tank closest to the engine held 58 liters of oil. Directly behind the oil tank was a 138-liter fuel tank. With the introduction of the A6M3, the arrangement changed to two smaller tanks: 54 liters of oil and 60 liters of fuel respectively. This layout continued through the A6M7 model. The aft fuselage was left dry until the introduction of the A6M7, which incorporated a 140-liter fuel cell.

Standard armament

The standard armament for the Zero A6M2a Model 11 and A6M2b Model 21 was two 7.7mm machine guns located in the nose between the forward fuselage and the cockpit with gun troughs running atop the engine cowling, and two 20mm cannons (one in each wing). Each wing could be fitted with a bomb rack capable of carrying a 30kg or 60kg bomb. The machine guns could be charged from inside the cockpit, and were synchronized to fire through the propeller's arc. The Type 97 machine guns were air cooled and based on the Vickers class E type. The guns were belt fed and had a firing rate of 900 rounds per minute, with a total of 700 rounds (7.7x56mm) for each gun. The Type 99 20mm cannons in the wings were a license-built version of an Oerlikon FF design, manufactured by Dai Nihon KK. The design was chosen for its small size, light weight, and ability to fire explosive shells. However, the type had drawbacks: low muzzle velocity and a slow rate of fire (520 rounds per minute). Each cannon was drum fed with 60 rounds for each cannon. The cannons were mounted in the inner wing, with gun ports on the wing's leading edge. The cannons were small enough that the barrels did not protrude outside the wing, leaving a clean silhouette.

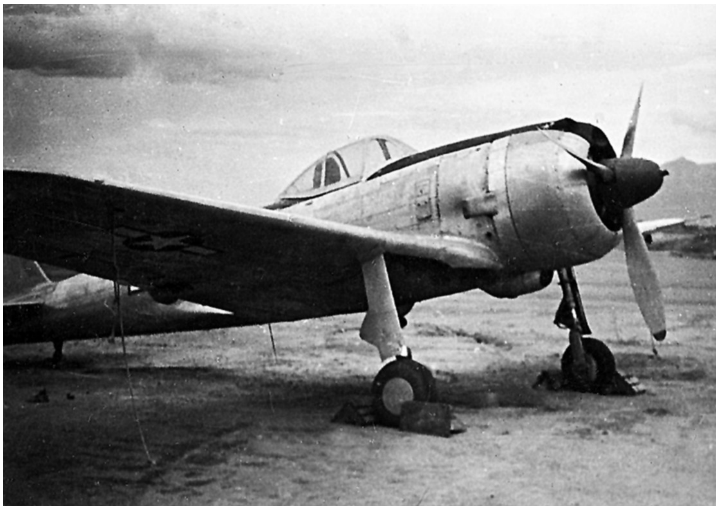
With the introduction of the A6M3 Model 32 came a new version of the Type 99 20mm cannon, the Mark 1 Model 2. The new cannon's magazine drums held 100 rounds each, nearly doubling the amount of ammunition per cannon. A long-barreled version of the Type 99, known as the Mark 2 Model 3, was introduced during the production run of the A6M3 Model 22. The most dramatic increase in firepower emerged during the production of the A6M5 – the Type 99 Mark 2 Model 4 cannon. These new cannons were belt fed and could carry an additional 25 rounds per cannon (125 rounds each). Fairings were added to reduce parasitic drag caused by the protruding barrels. The cannons were installed starting with the 4,651st aircraft, leading to the designation A6M5a.

The A6M5b variant began in April 1944, when the starboard 7.7mm machine gun was replaced with a Type 3 13.2mm gun. The A6M5c had the port 7.7mm machine gun removed while retaining the 13.2mm gun. Two additional 13.2mm machine guns were installed, one in each wing outside of the 20mm cannon. The ammunition boxes for the Type 3 guns were stationed in the outer wings. The final production version of the Zero, the A6M7, had a similar armament to that of the A6M5c, but incorporated a slightly recessed centerline bomb rack.

The discredited myths

The Zero's success against some of the world's frontline fighters sparked rumors that Japan's A6M was a creation of the West. These stories started from the belief (based on prejudice) that the Japanese were incapable of producing, or lacked the foresight to create, such a machine. Furthermore, US intelligence had failed to report Japan's most recent aircraft development and usage. Most American officials believed the Mitsubishi A5M was still the IJN's frontline carrier-fighter despite the fact that the Zero had first seen combat in September 1940 over China.

The most famous claim against Japan's ownership of the Zero emerged in journalist Drew Pearson's article, "Secret files Reveal United Aircraft Deal," featured in the Bridgeport, Connecticut *Sunday Herald* (Bridgeport was the home of Chance Vought, a United Aircraft Company). Pearson alleged that the Japanese bought the original Zero from the Chance Vought Company. The Japanese government had indeed



Sometimes described as the "Army Zero" by Allied pilots, the IJAAF's Nakajima Ki-43 Hayabusa (Allied reporting name Oscar) was often misidentified as a Zero. The Hayabusa's light weight and low wing loading gave it similar flight characteristics as its Navy cousin, and made it a formidable opponent in a dogfight. (USN) purchased foreign aircraft prior to the war, including the American-built Seversky P-35 and a single Chance Vought V-143.

The Japanese aviation industry was in fact heavily influenced by foreign engineers and foreign designs. The IJN in particular was influenced by British designs, while Japanese Army aviation followed French and German designs. Mitsubishi and other Japanese companies not only hired foreign designers and paid for patent licenses but also purchased examples of foreign aircraft and engines for research in order to catch up with the West. While employed by Mitsubishi, Horikoshi traveled the world to study aircraft designs. In his book *Eagles of Mitsubishi, the Story of the Zero Fighter*, Horikoshi acknowledged that the Chance Vought V-143 inspired the Zero's landing gear retraction system, and that other Western designs inspired the engine mount and engine cowl. He wrote:

> It is no exaggeration to say that we did look upon the general design or basic configuration of foreign airplanes with great respect. Any designer who fails, out of vanity, to adapt the best techniques available to him, fails to do his job. All engineers are influenced by their teachers, by their experience, and by the constant stream of scientific information that is placed at their disposal. Those influences did not equal a Western plane.

The wings, fuselage, and empennage of the V-143 had nothing in common structurally with the A6M.

A second myth was created by none other than Howard Hughes during an interview with a reporter from *Look* magazine in 1954. He said, in part:

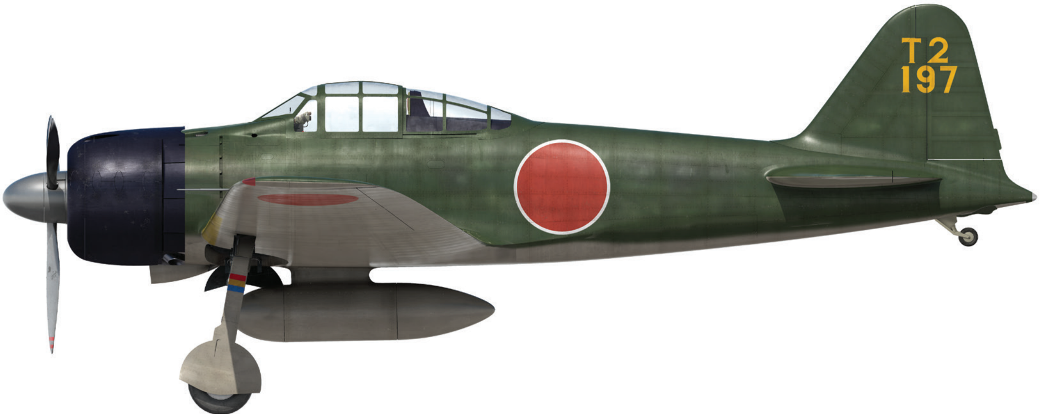
> I should say in point of aircraft design and mechanical aptitude… nobody expected the Japanese to have an airplane that would be at all competitive. Well, in any event, when one of these Japanese Zeros was finally captured and studied and analyzed it was quite apparent to everyone that it had been copied from the Hughes [H-1] plane.

Horikoshi was teaching at the Nihon University in Tokyo when he heard about the Hughes claim. He responded that there was nothing traceably foreign in the design of the Zero, and stated that the predecessor of the Zero was the A5M Type 96 carrier-fighter. Indeed, after close study of the Zero fighter, it became apparent that the aircraft was indeed an indigenous design. The near-impossible range and performance requirements set forth by the IJN had forced Horikoshi's team to create something new. A feature that stood out from typical Western fighter designs of the period was the use of a one-piece wing and integral cockpit to strengthen the overall wing design. The use of Extra Super Duralumin (ESD) for the majority of the airframe, and the wing spar as a weight-saving measure were also novel. As with the earlier A5M, the A6M would be underpowered from the start, but all of the design features built into the A6M took this into account.

B

MITSUBISHI WORKS A6M3 MODEL 32 (T2-197), F1/C KENJI YANAGYIA, 204TH KOKUTAI, EAST AIRFIELD, RABAUL, APRIL 1943.

This aircraft was flown by F1/C Kenji Yanagyia on an ill-fated mission to escort two Mitsubishi G4M bombers utilized as transports by Adm Isoroku Yamamoto, Commander in Chief of the Combined Fleet, and his staff on April 18, 1943. The six Zero fighters failed to stop 16 Lockheed P-38s from the 339th Fighter Squadron from successfully destroying both Betty bombers, killing Adm Yamamoto and his staff. Kenji Yanagyia reportedly damaged a P-38 after the ambush; US records show that one P-38 failed to return from the mission.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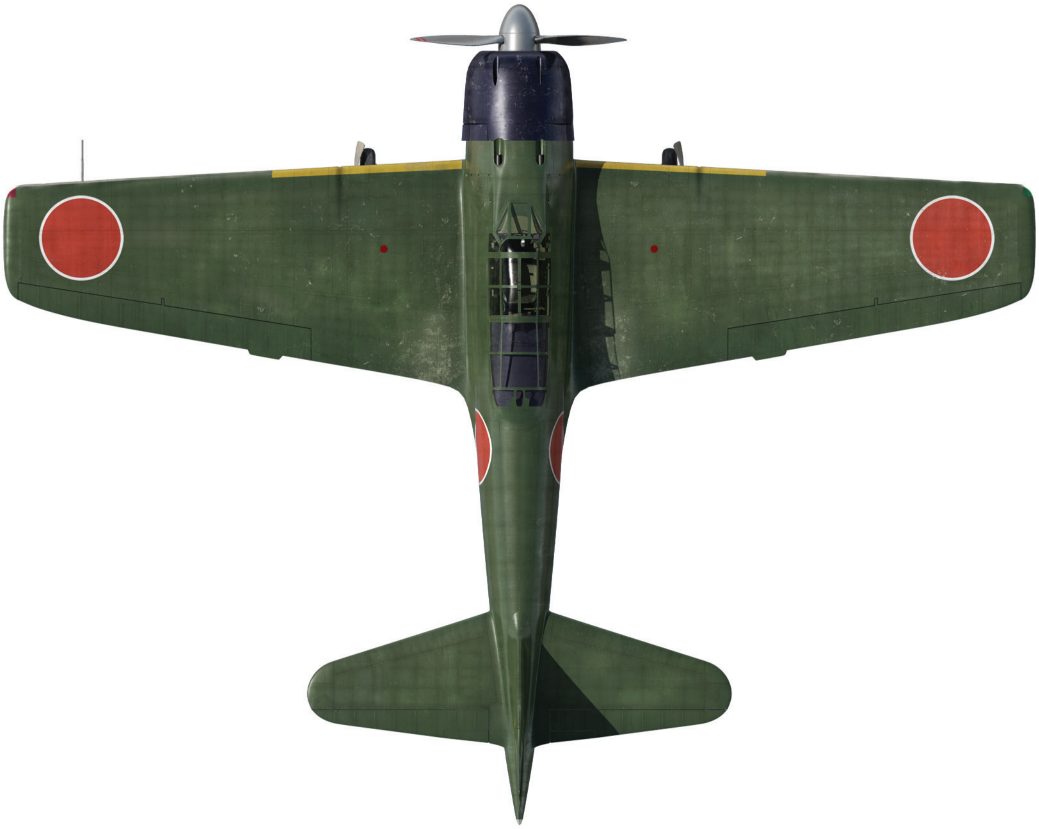
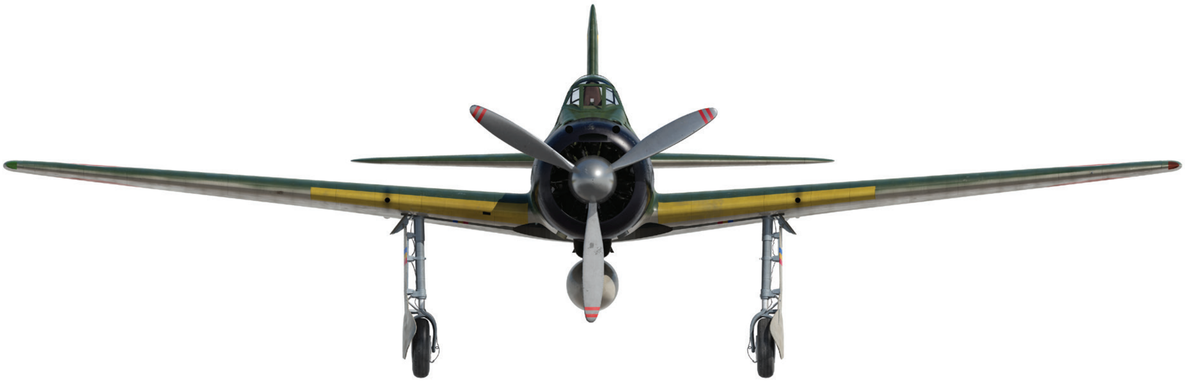




A pair of A6M2a Model 11s from the 12th Kokutai during an attack on Nanchong, May 26, 1941. Note the canopy glazing extends to the end of the canopy, denoting these aircraft as early production Model 11s. (IJN)

The other issue at odds with both stories was that the Zero was built as a carrier-fighter. It was nearly unheard of for a carrier-fighter, with its inherent penalties (having to conform to the dimensions of a carrier's elevator, the additional weight of having stronger/heavier landing gear and an arresting hook), to not only compete with but surpass land-based fighters in performance. The first American-built naval fighter to accomplish this feat was the Vought F4U Corsair.

In January 1941, the IJAAF proposed a joint contest at Yokosuka Air Base to evaluate new fighter designs against each other. The Army entered three aircraft, all built by Nakajima: the Ki-43 Hayabusa, the Nakajima Ki-44 Shoki interceptor, and a modified Ki-27. The IJN's sole entry was the Mitsubishi A6M2 Zero. All four aircraft would be evaluated on maneuverability in a dogfight, climb performance, turn performance, speed, and dive performance. The contest was well suited to give the Army aircraft the upper hand as range and the ability to land on a carrier were not evaluated or taken into consideration. However, it was the Navy's Zero that proved to be the best all-around fighter, as it handily won each event except climb performance (won by the more powerful Ki-44 Shoki). The results of the contest helped win over older naval aviators who were still partial to the Type 96 (A5M).

TECHNICAL SPECIFICATIONS AND VARIANTS

IJN naming process

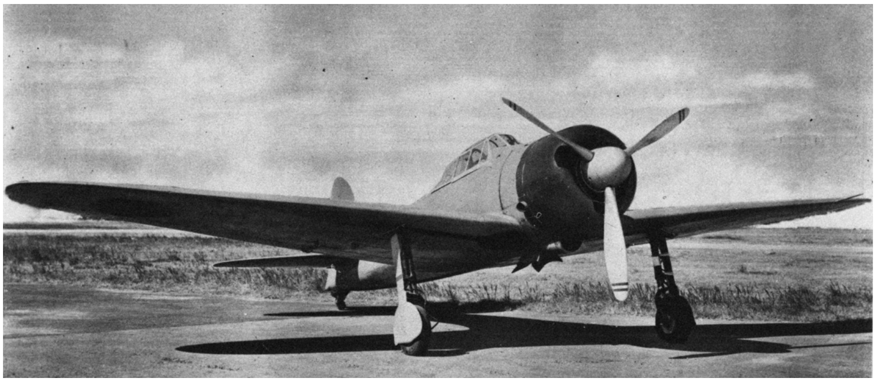
The IJN designated their aircraft utilizing a short designation system, in a similar fashion to that of the US Navy in the late 1920s. Each letter or corresponding number in the A6M2a designation has a meaning. The first letter describes the aircraft's function; in the case of the Zero the A stands for carrier-based fighter. The following number gives the generation: the Zero was the sixth carrier-based fighter fielded by the IJN. This was followed by a manufacturer letter, designating M for Mitsubishi. The next number (2) gives the model number, and a lowercase letter following the model number distinguishes a modification within that model. This is similar to the US Navy's designation for the F4U-1D Corsair. One of the major differences between the IJN and US Navy systems is that the US Navy system would differentiate between companies that license-built the original aircraft. In contrast, Zeros built by Nakajima and Hitachi are not given their own designation. Secondly, while the numeral 6 in A6M2 stands for the sixth carrier-fighter fielded by the IJN (regardless of manufacturer), in the US Navy system, using the F4U-1D as an example, the number 4 represents the fourth fighter built by Vought.

The model system was introduced by the IJN in 1942, and is quite useful in understanding the evolution of the Mitsubishi fighter. Significantly, each numeral designated a succession of airframe types and engine types. For instance, the Model 11 should be read as Model 1-1: (1) first production airframe, (1) first production engine; the Model 21 was (2) second production airframe, (1) first production engine, etc. This system is particularly helpful when dealing with the A6M3, which had multiple model numbers. The original A6M3, known as the Model 32, used the third airframe type with clipped wings, along with the second engine used in production. When it was determined the earlier airframe type was more beneficial, the designation changed to Model 22, as the engine did not change.

Mitsubishi A6M2a (Model 11)

First produced in December 1939 at Mitsubishi's Nagoya plant, the A6M2 (Model 11) featured a multitude of changes in comparison to the first prototypes. The powerplant was changed from the Mitsubishi Zuisei to the Nakajima Sakae-12 (14-cylinder radial engine), which produced 940hp, turning a CS40B Sumitomo/Hamilton Standard three-bladed constant-speed propeller. The new Sakae-12 powerplant had an up-flow carburetor, moving the placement of the carburetor intake from the top of the engine cowling to underneath. The vertical stabilizer and rudder on the production A6M2 was redesigned from the prototype, and the horizontal stabilizer was raised above the fuselage's centerline. The tail section was lengthened and the aircraft had a wider cross-section than the original prototypes.

The first five production A6M2s featured a combined air intake (with an internal split) for the carburetor and oil cooler under the engine cowling; this was later separated into two distinct intakes in tandem (carburetor forward and oil cooler intake aft) below the cowling, starting with the sixth aircraft produced. While the carburetor air intake had a pinched appearance on early A6M2s, this was later redesigned with a wider opening. The engine's exhaust exited the cowling at the fourth cowl flap on each side of the aircraft. Beginning with the 34th aircraft the exhaust opening was redesigned to exit lower at the fifth cowl flap. Early production A6M2s did not have the arresting hooks or radio homing devices utilized in carrier operations, since Mitsubishi engineers knew the first fighters would be serving from land bases while operating against China.



An early prototype A6M2b stationed at Yokosuka, Japan while undergoing testing. This photograph was used for the cover of the Zero handling manual issued to the fleet in the summer of 1942. (NARA)

Armament for the A6M2 consisted of two Type 97 7.7mm machine guns (700 rounds for each gun) firing out of gun troughs in the nose cowling, and two Type 99 20mm cannons drum fed with 60 rounds each (one in each wing). The aircraft could carry two 60kg or 30kg bombs (one on each wing). Late-model A6M2s (starting with the 45th aircraft off the production line) had reduced glazing at the rear of the canopy to aid disconnection of the aft fuselage from the cockpit for transportation purposes. The Model 11 could carry 518 liters of fuel internally (190 liters in each wing tank, and 138 liters in the forward fuselage tank) and was capable of carrying a 330-liter drop tank. Mitsubishi built all 64 A6M2 Model 11s (known as A6M2a after the introduction of the A6M2b). The fixed-wing Zero being rushed into production was one of the rarest operational Zero models. The type was later used as the basis for the A6M2-N float-fighter, which also utilized a non-folding wing. At the time of this publication, no surviving example of an A6M2a (Model 11) remains in existence.

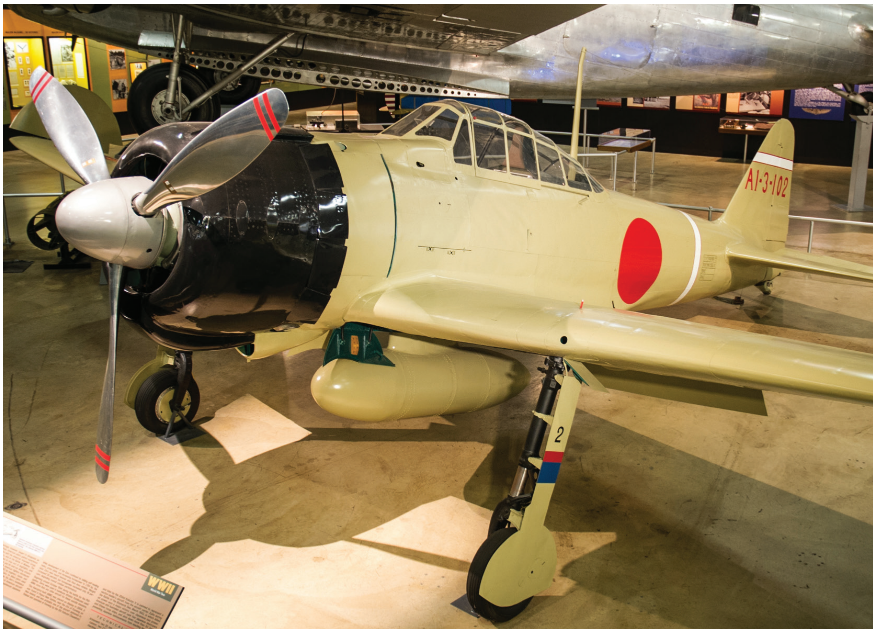
Mitsubishi A6M2b (Model 21)

Trials proved that the Model 11 wingspan was too large to operate within a carrier's elevator without risk of damaging the wing tips. In response, Mitsubishi looked at folding the wing tips under the wings, but eventually designed upward-folding wing tips. The manual folding wing tips were simple compared to traditional folding-wing design, which would have added significant weight to the aircraft, and reduced the span of each wing by 50cm. Mitsubishi Zeros produced prior to this were re-designated A6M2a while the new models with folding wing tips were known as A6M2bs. The Mitsubishi Zero A6M2b (later Model 21) was introduced in late 1940, starting with the 65th aircraft off the production line.

Beginning at the 127th aircraft produced, engineers added a protruding mass balance under each aileron. This feature was later deleted from the production line, starting with the 326th aircraft produced, following a fatal accident during a dive test in April 1941. The 326th aircraft also had redesigned gun ports for the 20mm wing cannons. The shape of the cockpit ventilation air intake on the starboard wing was redesigned to a rectangular shape starting with the 227th aircraft produced. The Naval Air Arsenal modified the ailerons to incorporate balance tabs; however, the balance tabs were later deleted due to their causing flutter problems. The Model 21 utilized the same 940hp Sakae-12 engine as the Model 11. Armament consisted of two Type 97 7.7mm machine guns (700 rounds each), and two Type 99 20mm cannons (drum fed) with 60 rounds each (one cannon in each wing). Each wing could carry either a 60kg or a 30kg bomb. Standard equipment included a radio homing device, and an arresting hook for carrier operations.

Nakajima A6M2b (Model 21)

The Zero's dominance in China prompted the IJN to push for additional production. The Nakajima Hikouki Company started producing the A6M Zero carrier-fighter under orders from the IJN in November 1941. The first Nakajima-built Zeros were introduced into service in the spring of 1942. A total of 2,882 A6M2bs were built by Nakajima, at the company's Koizumi and Ota plants. Visual differences between Mitsubishi and Nakajima Zeros are subtle. The Nakajima-built A6M2bs have a longer, more pointed spinner.

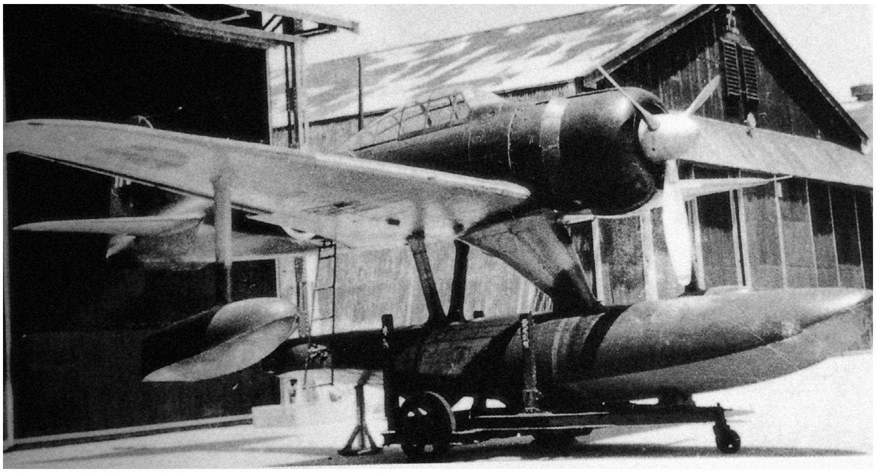


A Nakajima-built A6M2b Model 21 with its wingtips folded, emphasizing the major difference from the original A6M2a. The manually folded wingtips reduced the overall wing span by about 1m. This aircraft, on exhibit at the National Museum of the United States Air Force, was painted to represent a Mitsubishi-built Zero from the IJN carrier *Zuiho*, circa 1943. The single horizontal stripe painted on the vertical stabilizer denotes a section leader's aircraft. (USAF)

Nakajima Model 21s were painted in the same overall gray paint scheme as Mitsubishi-built Zeros, but with a lighter shade owing to the company's sourcing paint from a different manufacturer. To make it easier to recognize a Nakajima-built Zero from a Mitsubishi-built A6M2b, Nakajima began painting a 75mm white border around the fuselage *hinomaru* (roundel). After a new camouflage scheme was introduced in the spring of 1943, Mitsubishi began using the white outlines on the fuselage roundel as well. However, ground crews in the field covered the white outlines with dark green and black paint for tactical reasons. Nakajima began a new recognition system with the introduction of the camouflage scheme. The gray paint color used on the underside of the aircraft would come up to the start of the horizontal stabilizer on Nakajima-built Zeros. This recognition system would continue until the end of the war.

A6M2b conversions: training fighter and fighter-bomber

As newer models of the Zero entered combat, the IJN repurposed older Model 21s. As with all Zero models (except the A6M2-N), the aircraft could operate with the aft fuselage tail fairing removed, in order for the aircraft to tow a fabric gunnery banner. A gunnery target banner could be carried on each wing; the target was stowed in a metal cylinder attached to the wing by a small bomb rack. Towing cables ran from the target cylinder to the towing cable mount at the tail of the aircraft. In many cases the radio, radio homing device, 20mm wing cannons, and lower main gear wheel covers were removed. The nose armament of two Type 97 7.7mm machine guns was retained for gunnery practice. In early 1944, the IJN desperately needed to replace their aging D3A dive bombers. As a stopgap measure many older Model 21s were retrofitted to carry a single 250kg bomb on a centerline bomb rack. These fighter-bombers became known as *Bakusen*, most of which were built by Nakajima. Many of these aircraft were selected for use as kamikaze aircraft later in the war due to this capability.

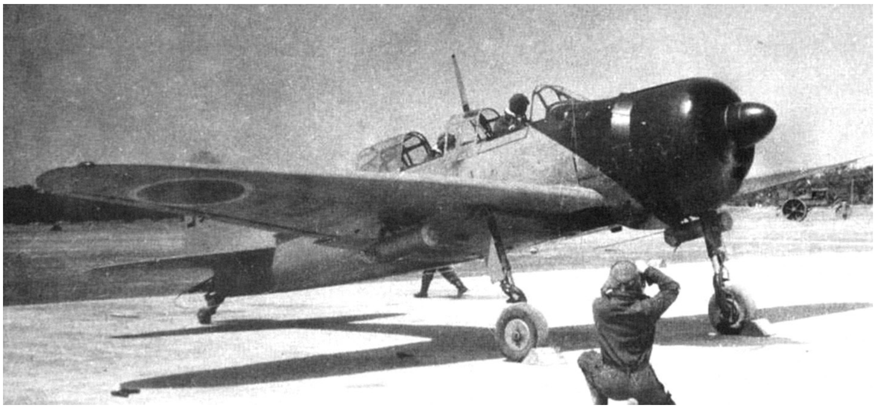


A Nakajima A6M2-N Type 2 Float Fighter (Allied reporting name Rufe) seen on its dolly outside a hangar at Kashima Air Base. The pilot accessed the cockpit of the A6M2-N by utilizing a ladder attached to the starboard fuselage. (IJN)

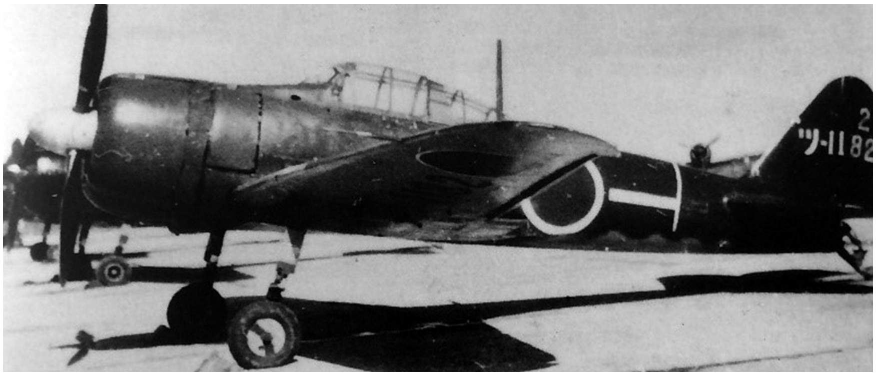
Nakajima A6M2-N Type 2 float-fighter

In 1941, the IJN asked Nakajima to build an interim float-fighter utilizing the A6M. The production would cease after the Kawanishi Kyofu float-fighter was ready for service. Nakajima were given the project, having prior experience in building seaplanes. The Type 2 float-fighter, based on the A6M2a Model 11 with non-folding wings, was given the designation of A6M2-N. Nakajima streamlined development time by incorporating the main float design from their E8N reconnaissance aircraft. The A6M2-N featured a large main float centerline and one auxiliary float on each wing. The main float doubled as a fuel cell; its centerline placement negated the use of the standard external tank utilized on other models. The oil cooler intake was relocated into the support structure for the main float. A ventral fin and a larger rudder were developed to aid maneuverability while water taxiing. Early production A6M2-Ns used the smaller Mitsubishi spinner.

The A6M2-N was not developed as an amphibian; the aircraft had no landing gear, and utilized a trolley-cart for the aircraft to get in and out of the water. In the absence of landing gear, the traditional anti-roll bar located inside the cockpit was never included. The first example was completed before the war, with its first flight taking place on December 7, 1941 (December 8 in Japan). The armament consisted of two 7.7mm machine guns, two 20mm Type 99 cannons, and mounts to carry a 60kg bomb on each wing.



An A6M2b training aircraft assigned to the Tsukuba Kokutai. The tail cone of this aircraft has been removed for target towing missions. The main gear wheel covers were removed for ease of maintenance. (IJN)



Hitachi-Works A6M2-K trainer of the Kounoike Kokutai preparing for a training mission, 1944. The aircraft is carrying target banners, contained within a metal cylinder attached to a Kai-1 small bomb rack under each wing. (IJN)

The Allies first faced the A6M2-N early in the war during the Aleutian campaign and gave it the nickname "Rufe." It was a formidable weapon despite the drag penalty of the large float. Surprised by the aircraft's speed (maximum speed 270mph) and effectiveness, the US Navy investigated the possibility of creating a similar aircraft based on the Grumman Wildcat, known as the F4F-3S Wildcatfish. Only one F4F was modified before the program was canceled, as the rapid speed at which American engineers were building airstrips made the aircraft unnecessary. Nakajima ended production of the Rufe in September 1943 with a total of 327 aircraft. The A6M2-N was never fully replaced by the Kawanishi Kyofu, codenamed "Rex" by the Allies, as only 90 were built before the IJN ended production.

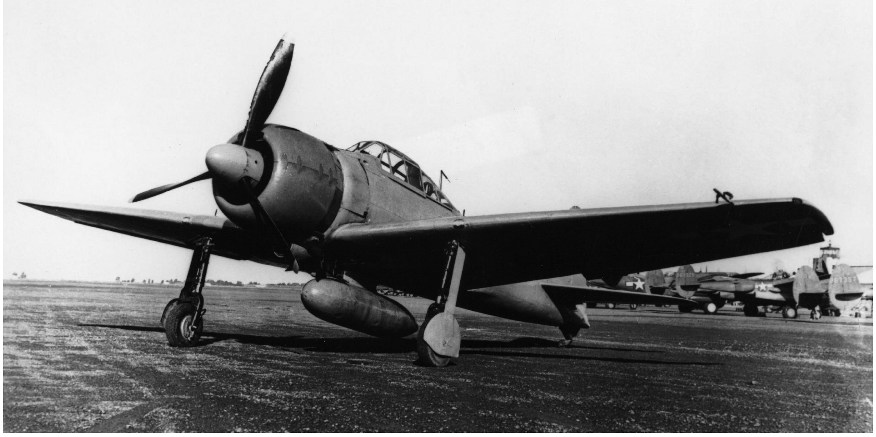
21st Naval Air Arsenal/Hitachi A6M2-K (trainer)

A two-seat trainer variant of the A6M2 was introduced in March 1944, developed by the 21st Naval Air Arsenal, based in Sasebo and produced by Hitachi. The aircraft was utilized to train Imperial Japanese Naval pilots who had completed intermediate training prior to being assigned to a fighter squadron. The Naval Air Arsenal designed the trainer based on the Model 21. Hitachi was contracted to produce the trainer in mass. The cockpit layout had the trainee fore and instructor sitting aft in tandem. The aircraft had dual controls, however only the rear seat had an enclosed canopy. The firewall was shifted aft and the fuselage had stabilizers added on each side forward of the horizontal stabilizers for stability. The landing gear differed in that the tailwheel strut was lengthened and fixed. The main gear was similar to the Model 21 with the exception that the strut cover was redesigned and the standard wheel covers were deleted for ease of maintenance. To compensate for the additional weight of the student, the wing-mounted 20mm cannons were deleted, but the A6M2-K would retain the two 7.7mm machine guns in the nose for gunnery training. Hitachi built 279 examples of the A6M2-K, with the Sasebo Naval Arsenal building 238 examples.

The clipped-wing Zero: Mitsubishi A6M3 (Model 32)

Initiated in early 1941, Mitsubishi's work on the A6M3 (Model 32) was the first and most dramatic redesign of the Zero fighter during its production. To increase the high-altitude performance over the Model 21, the new model incorporated a Nakajima Sakae-21 engine with a two-speed supercharger, producing 1,130hp. The new engine was paired with a larger-diameter

The A6M3 Model 32, with its clipped wings and streamlined cowling, was so distinct from the A6M2b that the Allies thought it was an altogether new fighter. Originally given the Allied reporting name "Hap" after General Hap Arnold, this was later changed to "Hamp" after he expressed his disapproval. (NARA)



Sumitomo/Hamilton three-bladed constant-speed propeller. The engine cowling was streamlined and incorporated the carburetor air intake at the top/center of the front of the engine cowling as the Sakae-21 had a down-flow feed carburetor. The new cowling also featured revised gun ports instead of the older gun troughs for the two 7.7mm machine guns. Mitsubishi began to test the A6M3 in June of 1941.

The most visually recognizable difference between the Model 32 and earlier Zeros was its squared-off wing tips, an idea that came about during testing. The wing folding mechanisms from the A6M2b were eliminated and the wing tips were squared off giving the A6M3 Model 32 better roll rates. The span of each aileron was shortened, also. The overall wingspan of the Model 32 was 11m. Although the A6M3 was primarily used from land bases, the aircraft was still equipped with an arresting hook and operated from carriers during its career. The wing armament was changed to two Type 99 Mark 1 Model 2 drum-fed cannons (one in each wing), with 100 rounds each. The underwing panels of the A6M3 Model 32 incorporated a slight blister to house the larger drums.

The shortened wings actually carried more fuel than the earlier models due to a wing rib redesign that allowed more internal space. Each wing had a 220-liter fuel cell compared to the previous 190-liter tanks. However, the forward fuselage oil tank was smaller and the fuselage fuel tank held 60 liters compared to the Model 21's 138-liter tank in order to accommodate the new Sakae-21 engine. The A6M2 held 838 liters total with a drop tank, and the A6M3 held 820 liters in the same configuration. The new engine increased not only the weight of the A6M3 but also its fuel consumption. The new Zero was heavier than the Model 21. The increase in fuel consumption, and decrease in overall fuel capacity, cut the range of the Model 32 by nearly 500 miles from the

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WEAPONS

1. Type 97 7.7mm machine gun
2. Type 3 13.2mm machine gun
3. Type 99 Mark 1 Model 1-Kai 20mm cannon
4. Type 99 Mark 2 Model 4 20mm cannon
5. Type 98 250kg general purpose bomb (fighter-bomber variants)
6. Type 99 No.3 Mk3 Model 1 (30kg air-to-air bomb)
7. Type 3 No.6 Mk3 Model 1 (60kg air-to-air bomb)
8. Type 3 No.6 Mk 27 Model 1 (60kg air-to-air rocket)

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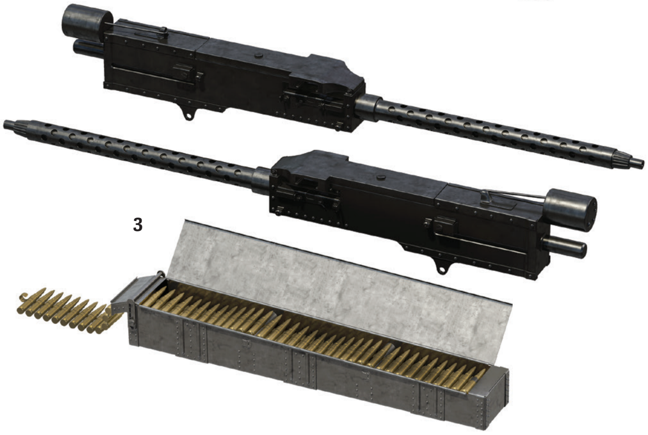

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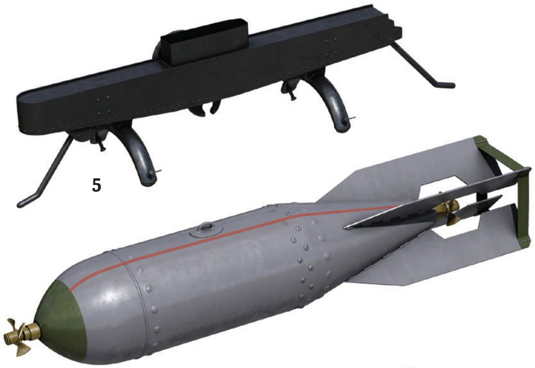

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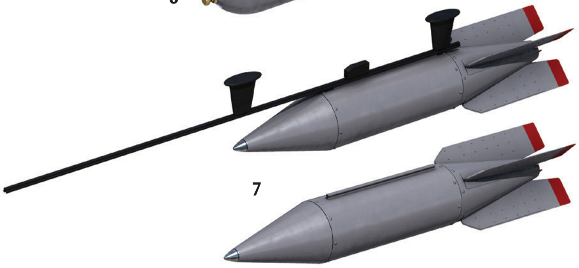

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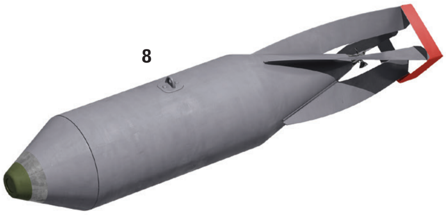
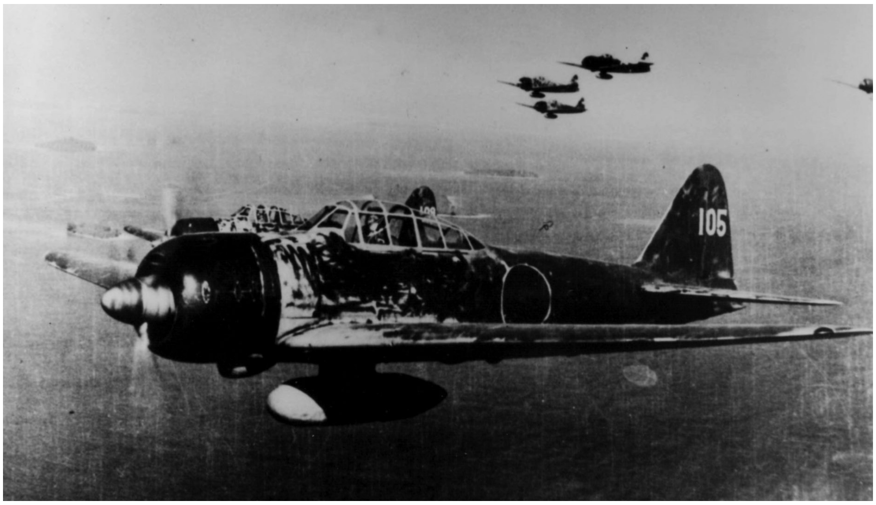




An A6M3 Model 22 from the 251st Kokutai. This photo was taken over the Solomon Islands in May 1943. The pilot, Hiroyoshi Nishizawa, was nicknamed "The Devil of Rabaul" and was considered Japan's highest-scoring ace, with 87 kills. His aircraft (tail code UI-105) wears a field-applied camouflage paint scheme. (NARA)

earlier Model 21. On July 15, 1941, the Model 32 made its first flight. The net gain in maximum speed was a disappointing 5mph. This dismal increase in speed came at the cost of the earlier Zero's range, and lateral maneuverability. The A6M3 did have better high-speed maneuverability than the earlier Model 21. Regardless of its shortcomings the IJN accepted the Model 32, though only 343 A6M3 Model 32s were built after production began in early April 1942.

Mitsubishi A6M3 (Model 22)

The Model 32's lack of range and lateral maneuverability made it unpopular with the IJNAF. In response, Mitsubishi restored the older 12m wingspan with folding wing tips to the next production model, designated the A6M3 Model 22. The designation stems from the use of a production airframe similar to the Model 21 paired with the second production engine. The wing on the Model 22 was visually similar in shape and size to the Model 21 but was a new design. The new wing incorporated an additional outer wing tank in each wing, and Mitsubishi restored the aileron balance tabs during production. The Model 22 was slightly heavier than the Model 32 due to its larger wing; however, range and lateral maneuverability were enhanced, with a minor cost in maximum speed performance (the Model 22 was 2mph slower than the Model 32). The range increase was slightly better than the A6M2b, giving it the best range of the Zero series.

Visual differences between the Model 22 and the Model 21 are subtle. Two visual recognition keys are the engine cowling (the same as that used on the Model 32) and the rudder (the Model 22 incorporated a rudder trim tab – this feature would be incorporated on all subsequent models). The Model 22 kept the same wing armament as the Model 32 (two Type 99 Mark 1 Model 2 cannons, one in each wing, drum fed with 100 rounds each). During production of the Model 22, the wing guns were later upgraded to the long-barreled Type 99 Mark 2 Model 3. Late-production Model 22s with the upgraded wing armament were designated Model 22-*Koh* or A6M3a. In an attempt to improve the firepower of the Zero a few Model 22s were fitted with 30mm cannons during a field test at Rabaul. Production of the Model 22 began in November 1942. By the summer of 1943 when production of the Model 22 ceased, Mitsubishi had produced 560 examples.

Zero specifications (Model 11–Model 22)						
Variant	**A6M2a**	**A6M2b**	**A6M2-N**	**A6M2-K**	**A6M3**	**A6M3**
	Model 11	**Model 21**	**Type 21**	**Type 11**	**Model 32**	**Model 22**
Engine	Sakae-12	Sakae-12	Sakae-12	Sakae-12	Sakae-21	Sakae-21
hp	940hp at	940hp at	940hp at	940hp at	1,130hp at	1,130hp at
RPM	2,550rpm	2,550rpm	2,550rpm	2,550rpm	2,750rpm	2,750rpm
Wingspan	12m	12m	12m	12m	11m	12m
Length	9m	9m	10.2m	9.1m	9.1m	9.1m
Height	3.2m	3.2m	4.3m	3.5m	3.5m	3.5m
Wing area	22.4m^2	22.4m^2	22.4m^2	22.4m^2	21.5m^2	22.4m^2
Weight						
Empty	1,706.9kg	1,745kg	1,921kg	1,819kg	1,807.1kg	1,863kg
Gross	2,388.7kg	2,420.8kg	2,459.8kg	2,334.2kg	2,534.7kg	2,679kg
Max speed	331mph	331mph	270mph	296mph	338mph	336mph
	at 14,930ft	at 14,930ft	at 16,405ft	at 13,125ft	at 19,685ft	at 19,685ft
Ceiling	33,070ft	33,792ft	33,238ft	33,398ft	36,253ft	36,253ft
Max range	1,930	1,930	1,107	860	1,447	1,615
st miles				(w/o drop tank)		(w/o drop tank)
Internal armament	7.7mm Type 97 machine gun (x2), Type 99 20mm cannon (x2). The A6M2-K trainer variant was produced without 20mm wing cannons.					

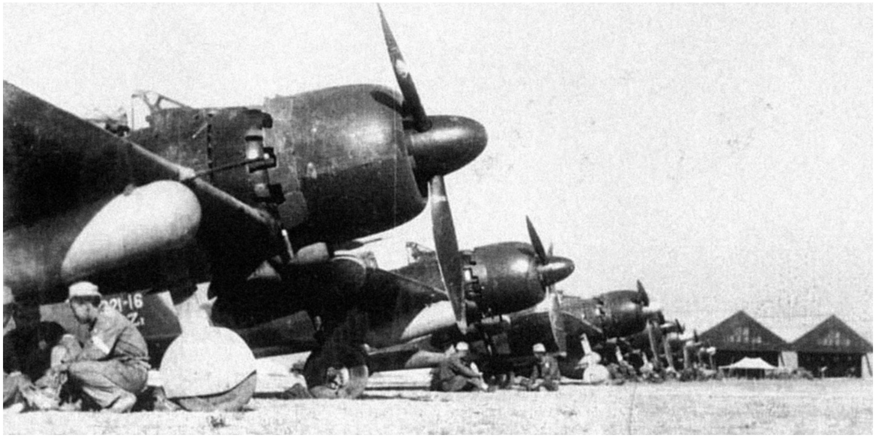
A6M5 Model 52

The Model 52 was Mitsubishi's attempt to counter the Allies' latest fighters, such as the F4U Corsair and F6F Hellcat, which were outperforming the Zero. Both American fighters utilized versions of the Pratt & Whitney R-2800 engine producing 2,000hp, nearly twice as powerful as the Zero's powerplant. Both the F4U and F6F had six synchronized .50cal machine guns (three in each wing) to give them a firepower advantage as well. Jiro Horikoshi described the F6F as "a fighter that could fight straight in the Zero's face." In 1943 Horikoshi was no longer responsible for Zero development. That responsibility was given to Mijiro Takahashi in order for Horikoshi to concentrate his efforts on the Mitsubishi J2M Raiden interceptor, and the A7M Reppu (considered the true successor to the A6M) struggled to satisfy Japanese officials, mainly due to the lack of a powerful enough engine. With nothing to truly replace it, the Zero had to carry on, even as newer generations of Allied fighters began to dominate the theater.

The changes Mitsubishi incorporated into the Model 52 created the fastest of the A6M models to see operational service. However, this was not through

This A6M5 was one of over a dozen Zeros captured on Aslito Field Saipan in June 1944. The Zeros were transported aboard the USS *Copahee* to the United States and divided between the USAAF and the USN for testing and evaluation. Photo taken September 9, 1944. (USN/NARA)

Ground crews take shelter from the sun under the wings of their A6M5b Zeros. The Model 52-*Otsu* could carry a wooden 300 liter centerline drop tank, and was the first Zero variant capable of carrying 150-liter wing tanks. (IJN)



increasing the engine's horsepower. The A6M5 utilized the same Sakae-21 (1,130hp) engine that powered the Model 32 and Model 22. Instead, the engine's exhaust system incorporated multiple pipes (six on the starboard side and five on the port side) instead of the two-pipe design (one on each side). The exhaust escaping directly behind the cylinder boosted thrust from the engine towards the rear of the aircraft. The engine's cowl flaps were redesigned to incorporate cutouts for the 11 exhaust pipes and heat shields were used to protect the fuselage. For safety, a fire extinguisher was provided for the engine.

The shortened wingspan also increased the speed of the new Zero. The wings were of similar length to the A6M3 Model 32, except that the wings for the Model 52 utilized rounded wing tips (with no folding mechanisms). Without the folding wing tip mechanisms, the Model 52's ailerons were extended out to the end of the wing, giving the A6M5 better roll rates. The Model 52's shorter wings did decrease range and maneuverability. The first prototype, made from a modified Model 22, first flew in August 1943. Test flights showed promise as it reached a top speed of 351mph.

Early production A6M5s can be recognized by their original Sakae-21 exhaust system and Model 32-style cowling due to a delay with the new exhaust ring. Later, production incorporated the new exhaust system, revised cowl flaps, and small heat shields. Subsequent A6M5s incorporated longer exhaust heat shields, a new radio, and a shorter radio mast. Also, late-production A6M5s did not have the engine fire extinguisher, but did include automatic wing tank extinguishers. The armament remained the same as that of the A6M3a Model 22.

Mitsubishi and Nakajima produced over 6,000 Model 52s (of all variants). Mitsubishi built 747 of the original A6M5 variants, with Nakajima building an unknown quantity. The number of variants also eclipsed any other Zero type. A fighter-bomber variant known as the A6M5 *Bakusen* was built from standard A6M5s and A6M5a-*Koh* variants. Naval Air Arsenals converted these aircraft in the same manner as the earlier Model 21 fighter-bombers, incorporating a single 250kg or 500kg bomb on a centerline bomb rack.

A6M5a Model 52-*Koh*

The Model 52-*Koh* saw an extensive armament upgrade. The 20mm cannons were now upgraded to the Type 99 Mark 2 Model 4 and had belt-fed ammunition (125 rounds each) instead of the drums. The skin of the wings was thickened by 0.2mm to enhance dive performance, and the gun ports for the 20mm cannons received fairings for the barrels. Mitsubishi built 391 of the A6M5a before ending production in 1944.

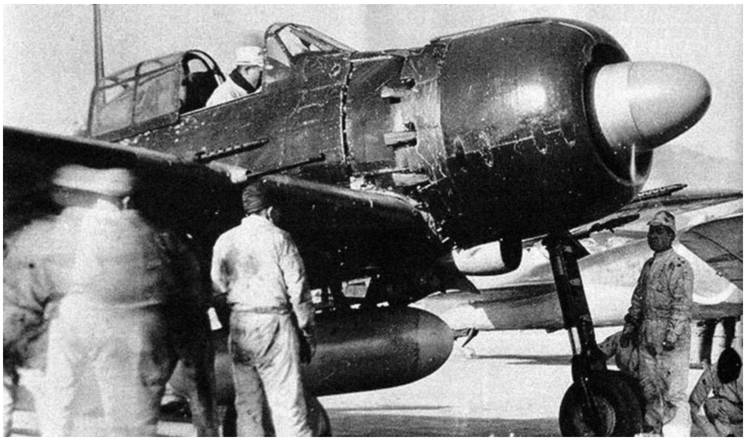
A night-fighter version of the A6M5a-*Koh* was built to fend off the increasing number of Allied night-time bombing raids. The night-fighter variant was modified from the standard Model 52. The aircraft had the same powerplant and armament as the Model 52 (two 7.7mm nose machine guns, and two long-barreled Type 99 Mark 2 Model 3 cannons in each wing), with one unique exception: a Type 99 Mark 2 Model 4 20mm cannon was stationed behind the cockpit firing forward-upward from the rear canopy at a 30-degree angle. The rear canopy was heavily revised to allow for a reinforced gun port (exiting on the left side of the canopy), and the glazing at the end of the rear canopy was removed and replaced with a metal panel. A small gun sight was added to the interior of the windshield frame for firing the fuselage-mounted 20mm cannon. Unlike most Allied night-fighters, the Zero night-fighter had no radar equipment and no exhaust/flame dampeners.

A6M5b Model 52-*Otsu*

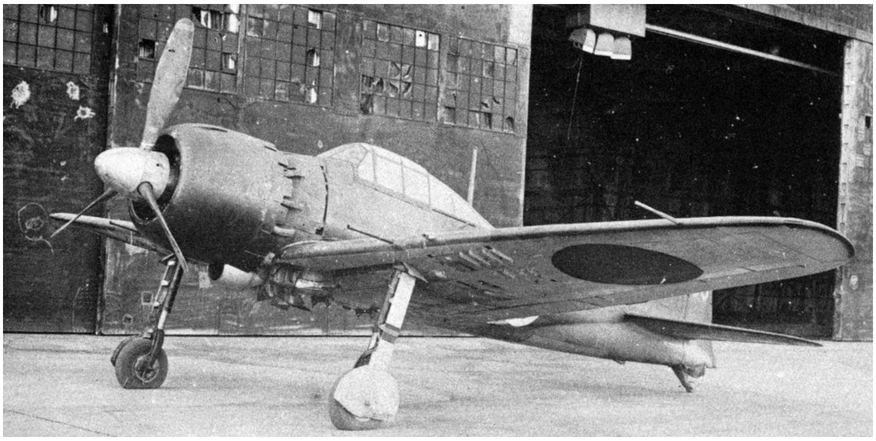
The Model 52-*Otsu* brought multiple new features to the Zero range. The A6M5b was the first variant to incorporate the Type 3 13.2mm machine gun (in place of the starboard 7.7mm machine gun). The starboard gun port on the engine cowling, feed belt access panel, and gas outlet were redesigned specifically for the new weapon. The Model 52-*Otsu* was also the first variant to include protection for the pilot. A 45mm-thick bullet-resistant glass was installed in the front windshield; however, no armor plating was added. An automatic fire extinguisher was added to protect the fuselage fuel cell. The Model 52-*Otsu* could carry a new wooden 300-liter centerline drop tank, and was the first variant to use 150-liter wing tanks. Mitsubishi built 470 of this model; Nakajima also produced the Model 52-*Otsu*, however the numbers that it built are unknown.

A6M5c Model 52-*Hei*

The last variant of the A6M5 to go into full production was the Model 52-*Hei*. Both protection and armament were bolstered in this last variant. The A6M5c incorporated two Type 3 13.2mm machine guns with cooling jackets, one in each wing outboard of the Type 99 Mark 2 20mm cannon. The nose armament was changed with the deletion of the port 7.7mm machine gun (the 13.2mm was retained). To house the new wing machine guns the outer panels of the wings were redesigned from the basic Model 52-*Otsu*. The A6M5c variant could carry four rockets or bombs (30–60kg air to air) under each wing. Additionally, 55mm bullet-resistant glass was added to the rear canopy, as well as 8mm of armor plating



An IJNAF ground crew ready a Nakajima-Works A6M5c assigned to the Genzan Kokutai, Wonsan, Korea, for an upcoming move to Kyushu, Japan, April 1945. (IJN)



The A6M7 was purposely built as a fighter-bomber. The Model 63 was capable of carrying an external fuel tank or a single 250kg bomb on a recessed centerline station. Note the fixed bomb/rocket swing stoppers on the underside of the port wing. (DoD)

positioned behind the pilot's seat. The protection and armament additions increased the type's combat survivability, at the loss of some maneuverability and range.

The A6M5c Model 52-*Hei* variant weighed 2,155kg empty, making it the heaviest Zero to see combat and slower than the A6M3 Model 32. The first flight took place in November 1944. Mitsubishi produced only 93 aircraft of the type, with Nakajima building an unknown number.

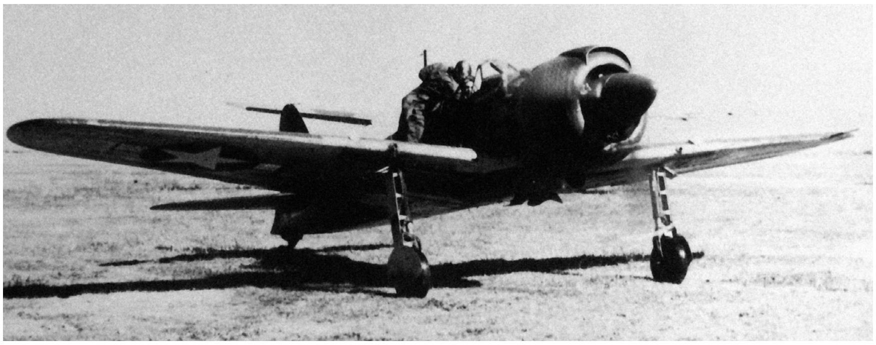
A6M5-K (trainer)

The 21st Naval Air Arsenal completed work on a trainer based on the Model 52 in early 1945. The new trainer was devoid of all armament, unlike the earlier A6M2-K model which still had two 7.7mm guns in the nose. Hitachi was selected by the IJN to begin production of the new trainer. However, the war ended before full production began. Only seven pre-production A6M5-K trainers were built.

A6M7 Model 63

The last operational Zero of the war was the A6M7 Model 63. It was an attempt by the IJN to replace its obsolete Aichi D3A (Val) dive bombers with a dedicated fighter-bomber version of the Zero. Unlike earlier attempts using stopgap measures with modified A6M2b and A6M5 *Bakusen* aircraft, the A6M7 included considerable design changes, such as thicker skin on the vertical stabilizer to handle the stresses of dive bombing as well as the capability to carry a heavier payload on the centerline station. The A6M7 had a similar armament layout to that of the A6M5c; however, the new model had a recessed centerline bomb rack capable of carrying a 250kg bomb, a 500kg bomb, or the option to carry a centerline station drop tank. The new model also incorporated fixed bomb/rocket swing stoppers, located on the underside of the wings.

The A6M7 had a new powerplant, the Sakae-31, which produced 1,130hp on takeoff, the same as the earlier Sakae-21 powerplant. Some A6M7s were powered by the Sakae-31-*Koh* engines with water methanol injection, producing a maximum of 1,210hp. As experienced with the earlier A6M6c, attempts to use water methanol-boosted engines found little success. The Model 63 carried two additional external wing tanks holding 150 liters each.



One of only two Mitsubishi Works A6M8 prototypes, wearing US markings after the war. The prototypes were powered by Mitsubishi-built Kinsei-62 radial engines. (USAF)

The internal wing tanks held 155 liters each, while the outer wing tanks held 25 liters each. An additional 140-liter fuel tank was located in the aft fuselage. The aft fuselage was reinforced to handle the weight of the additional tank. The A6M7 prototype flew in May of 1945 and production was started in the same month. The number of A6M7s built by either Mitsubishi or Nakajima remains unclear.

A6M8c Model 54

The late variant A6M5's performance declined with the additional weight of armor protection and bullet-resistant glass. The A6M8c was designed in an attempt to restore the performance of the original Model 52. The new aircraft was fitted with a Mitsubishi Kinsei-62 (14-cylinder) radial engine producing 1,560hp at takeoff. (This engine was used to power the Yokosuka D4Y3 ("Judy"dive bomber.) This was the first time a Mitsubishi powerplant had been used on a Zero since the A6M1 prototype. The Kinsei-62 engine was made available by the IJN due to a shortage of Sakae engines. The A6M8c was armed with two Type 3 13.2mm machine guns and two Type 99 Mark 2 20mm cannon (one in each wing). The nose armament was eliminated due to the new engine. The Kinsei-62 incorporated a large carburetor intake on top of the cowling.

Two prototype aircraft were built from Model 52 aircraft; the first was completed in late April 1945, with the second accepted by the IJN in June. Mating the Kinsei-62 to a Zero airframe showed promise; during a test flight the A6M8 reached a top speed of 355mph at 20,000ft in level flight. Many of the test pilots deemed the A6M8 prototype to be the best Zero model they had flown, and the two test aircraft were by far the fastest Zeros built. Mitsubishi initiated production, but the war ended before a production model could be completed. Had the A6M8c been fielded it would have used the model designation Model 64, as the new model was to be based on the A6M7 airframe. Even if fielded, the A6M8 would have struggled against the latest versions of Allied fighters like the F4U-4 Corsair, P-51D Mustang, and the Republic P-47N Thunderbolt, all of which had maximum speeds in excess of 430mph.

A6M8c	*Powerplant*	*Dimensions*	*Performance*	*Internal armament*
Numbers built: 2	Mitsubishi Kinsei-62 1,560hp	Wingspan: 11m Length: 9.2m Height: 3.5m Wing area: 22.4m^2 Weight/empty: 2,154.6kg Weight/loaded: 3,150.2kg	Max speed: 355mph at 19,685ft Ceiling: 35,367ft Range: 1,312nm	2x 20mm cannons 2x 13.2mm MG

Zero specifications (Model 52–Model 63)

Variant	A6M5 Model 52	A6M5a Model 52-*Koh*	A6M5b Model 52-*Otsu*	A6M5c Model 52-*Hei*	A6M7 Model 63
Powerplant **Horsepower**	Sakae-21 1,130hp at 2,750rpm	Sakae-21 1,130hp at 2,750rpm	Sakae-21 1,130hp at 2,750rpm	Sakae-21 1,130hp at 2,750rpm	Sakae-31a 1,130hp at 2,300rpm
Wingspan	11m	11m	11m	11m	11m
Length	9.1m	9.1m	9.1m	9.1m	9.1m
Height	3.5m	3.5m	3.5m	3.5m	3.5m
Wing area	21.3m^2	21.3m^2	21.3m^2	21.3m^2	21.3m^2
Max speed	351mph	351mph	351mph	335mph	337mph
Weight					
Empty	1,855.6kg	1,855.6kg	1,855.6kg	2,155kg	2,049.8kg
Gross	2,742.9kg	2,742.9kg	2,742.9kg	3,149.8kg	2,999.6kg
Service ceiling	38,549ft	38,520ft	38,520ft	36,253ft	33,398ft
Max range	1,194nm	1,194nm	1,194nm	1,312nm	943nm
Internal armament	2x 7.7mm MG 2x 20mm cannons	2x 7.7mm MG 2x 20mm cannons	1x 7.7mm MG 1x 13.2mm MG 2x 20mm cannons	1x 7.7mm MG 3x 13.2mm MG 2x 20mm cannons	3x 13.2mm MG 2x 20mm cannons

Variant summary

Designation	Base model/model number	Engine	Notes
A6M1	None	Zuisei-13	Two flying prototypes (a third built for structural tests)
A6M2a	Model 11	Sakae-12	Carrier-fighter (fixed-wing)
A6M2b	Model 21	Sakae-12	Carrier-fighter (folding wing tips)
A6M2-N	Model 11	Sakae-12	Nakajima float-fighter
A6M2-K	Model 21	Sakae-12	Two-seat trainer
A6M3	Model 32	Sakae-21	Carrier-fighter with clipped wing
A6M3	Model 22	Sakae-21	Carrier-fighter with full wing, with folding wing tips
A6M3a	Model 22-*Koh*	Sakae-21	Upgraded wing armament
A6M4	Model 32	Sakae-21	Prototype with a turbo-supercharged Sakae-21 engine
A6M5	Model 52	Sakae-21	Carrier-fighter, shortened wing without folding tips
A6M5a	Model 52-*Koh*	Sakae-21	Upgraded wing armament, wing skin thickened
A6M5b	Model 52-*Otsu*	Sakae-21	Bullet-proof glass, wing tanks, upgraded nose armament
A6M5c	Model 52-*Hei*	Sakae-21	Upgraded wing armament, armor protection
A6M5-K	Model 52	Sakae-21	Trainer similar to the A6M2-K (7 prototypes built)
A6M6	Model 52	Sakae-31a	Prototype powered by a water methanol injected Sakae-31a engine and self-sealing fuel tanks.
A6M7	Model 62/63	Sakae-31	Fighter-bomber
A6M8	Model 54	Kinsei-62	Mitsubishi Kinsei-62 powerplant (two prototypes built)

D

1. Mitsubishi Works A6M3a Model 22-*Koh*, 582nd Kokutai, Lt Cmdr Saburo Shindo, Buin, June 1943.
2. Nakajima Works A6M5 Night-Fighter (32-89), 332nd Kokutai, Iwakuni AB, January 1945.
3. Hitachi Kokutai KK Works A6M2-K (428), Genzan Kokutai, Wonsan Korea, March 1945.
4. Nakajima Works A6M5c Model 52-*Hei*, 203rd Kokutai, CPO Takeo Tanimizu, June 1945.

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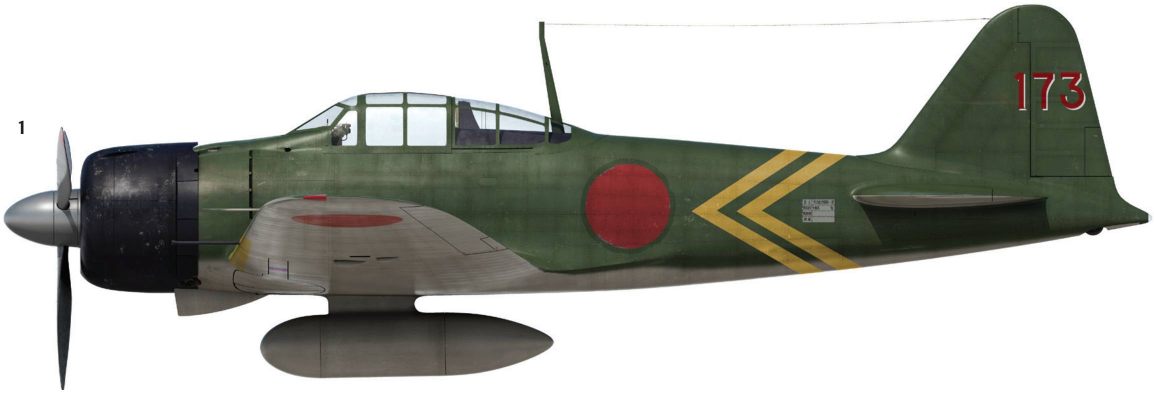

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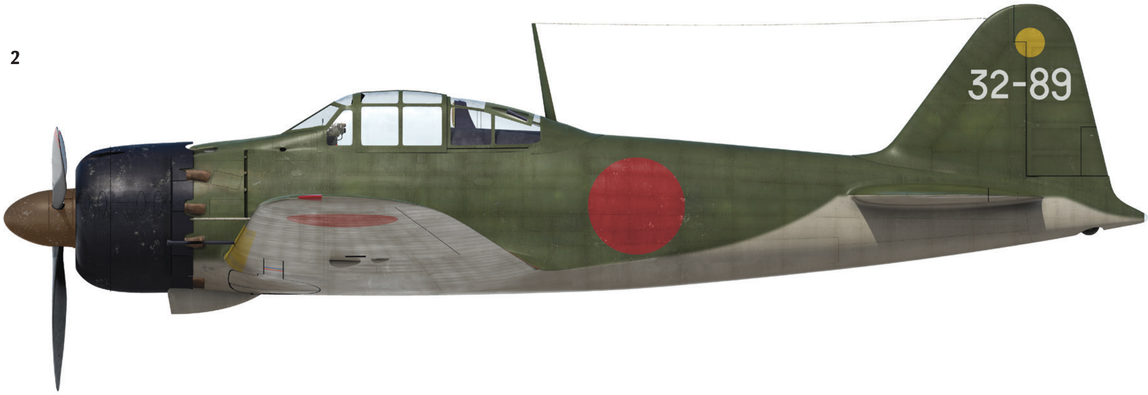

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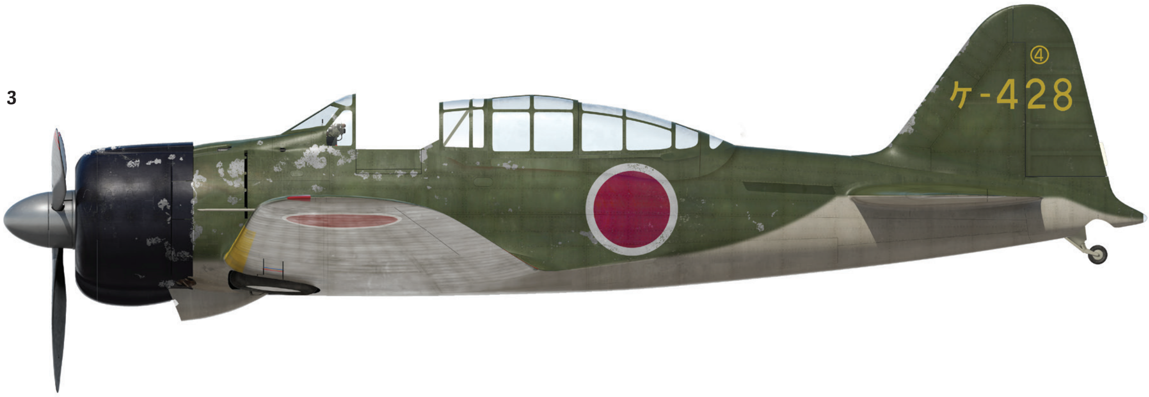

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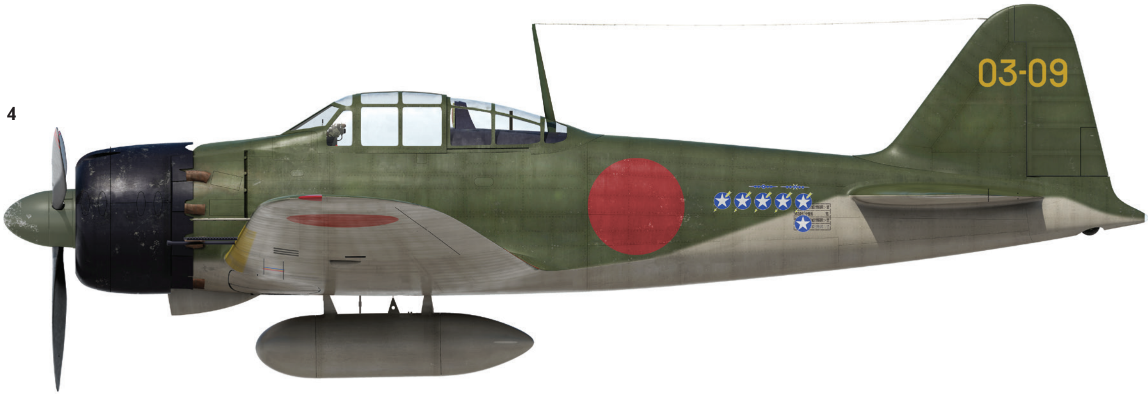


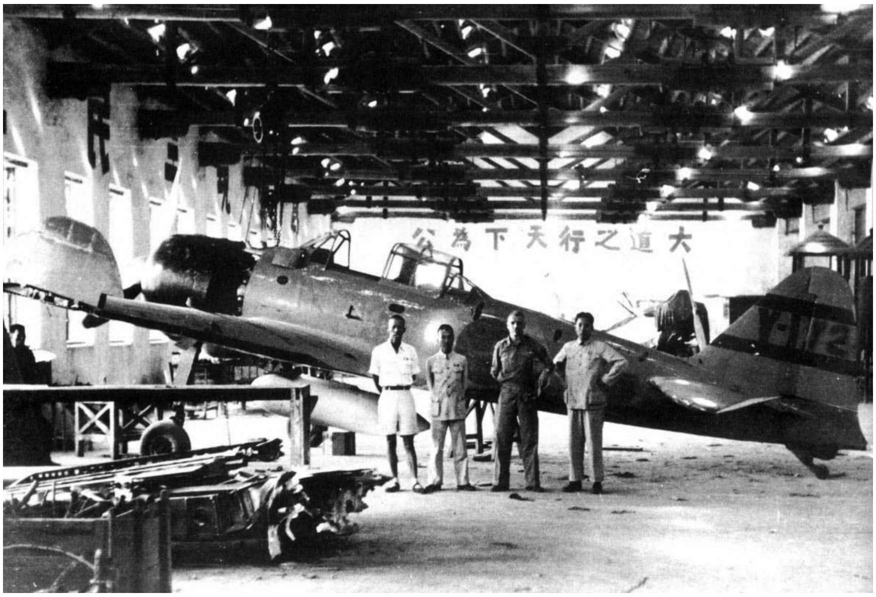
Zero production by model and company			
Type/model	**Company**	**Produced**	**Year introduced**
A6M2a Model 11	Mitsubishi	64	1940
A6M2b Model 21	Mitsubishi/Nakajima	864/2,882	1940
A6M2-N float-fighter	Nakajima	327	1941
A6M3 Model 32	Mitsubishi	343	1942
A6M3 Model 22	Mitsubishi	560	1943
A6M3a Model 22-*Koh*	Mitsubishi	?	1943
A6M2-K trainer	21st Naval Air Arsenal/Hitachi	238/279	1944
A6M5 Model 52	Mitsubishi/Nakajima	747/?	1944
A6M5a Model 52-*Koh*	Mitsubishi/Nakajima	391/?	1944
A6M5b Model 52-*Otsu*	Mitsubishi/Nakajima	470/?	1944
A6M5c Model 52-*Hei*	Mitsubishi/Nakajima	93/?	1944
A6M7 (Model 63)	Mitsubishi/Nakajima	?/?	1945
? denotes unknown number produced by either Mitsubishi or Nakajima Mitsubishi/Nakajima production: 10,449 21st Naval Air Arsenal/Hitachi: 517			

OPERATIONAL HISTORY

Baptism of fire (China 1940–41)

In May of 1940, the IJN began bombing the Chungking area nearly 500 miles from their base at Hankow, China. Their frontline fighter, the Mitsubishi A5M, did not have the range to accompany the Mitsubishi G3M bombers on their 1,000-mile round-trip flight. As these raids continued, Chinese fighters exacted a heavy toll on the bomber formations. In response, the IJN rushed their newest fighter into the theater. Mitsubishi had built 15 pre-production aircraft when the orders arrived. These fighters were assigned to the 12th Kokutai stationed at Hankow Airfield, China.

Deployed in July 1940, their first combat sortie was flown on August 19, 1940, led by Tamotsu Yokoyama. Chinese intelligence had learned of the



This Mitsubishi-built A6M2b (manufacturer number 3372) was the first intact Zero captured on November 26, 1941, by Chinese forces. A pair of Zeros from the Tainan Kokutai got lost in heavy fog and made forced landings on the coast of Leichou Peninsula in southeastern China. Only one was rebuilt. This aircraft was later tested in the US at Wright Field, Ohio, in 1943. (USAAF) deployment of Japan's latest fighter and initially avoided direct confrontation. However, on September 13, 1940, the Zeros drew their first blood. During the return trip of an escort mission over Chungking, a Japanese reconnaissance plane reported enemy fighters arriving behind the formation. Lt Saburo Shindo, the Zero flight leader, reversed course, gained altitude, and positioned his fighters with the sun behind them. They found over 30 Chinese aircraft (I-15 and I-16 fighters) and ripped into them, claiming a total of 27 Chinese fighters, with no losses of their own (four Zeros received light damage). One pilot, Flight Warrant Officer Koshiro Yamashita, destroyed five aircraft during the mission, becoming the first Zero ace. The mission earned the unit a special commendation from the commander in chief of the China area fleet. Vice Adm Teijiro Toyota, the Chief of the Navy Bureau of Aeronautics, sent a letter of appreciation to all three companies involved in creating the new fighter: Mitsubishi who had built the airframe, Nakajima for its powerplant, and Dai Nihon Heiki, who had built the 20mm cannons.

On October 4, 1940, eight Zeros were tasked with escorting bombers against Chengtu for the first time. The Zeros attacked Taipingssu Airfield, claiming six aircraft before strafing the airfield. With the enemy base in disarray, four pilots actually landed on the field while four other Zeros acted as top cover. The pilots leapt from their aircraft while their engines were running and attempted to destroy undamaged Chinese aircraft. Chinese soldiers soon rallied, but all four aircraft were able to escape.

After 70 missions over China, from August 1940 through September 1941, A6M2 pilots claimed victories over 103 aircraft in air-to-air combat, and another 163 aircraft damaged on the ground. A total of two Zeros were destroyed by ground fire, while 39 received some damage.

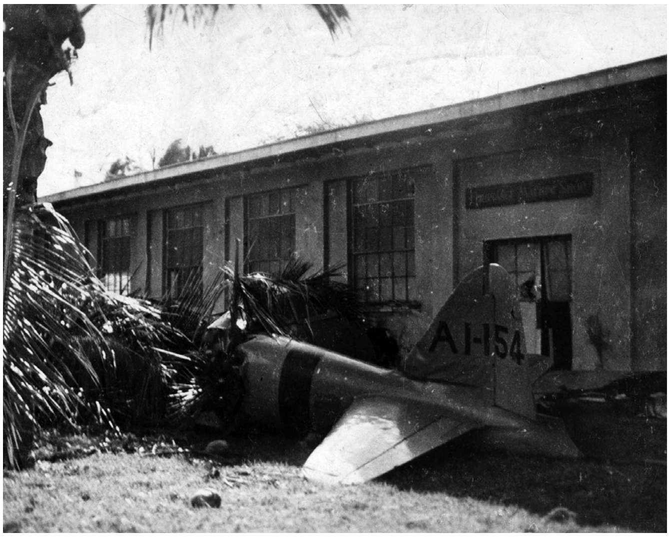
The Hawaiian operation: Pearl Harbor

By December 7, 1941, the IJNAF had just under 400 A6Ms in service. Japanese intelligence estimated that the Mitsubishi Zero's performance would give it a five-to-one kill ratio over Allied aircraft. This, combined with a cadre of veteran Zero pilots from combat over China, would significantly increase their chances of success against the West. The IJN ordered three months of intensive training in preparation for the Hawaiian operation. The Japanese task force consisted of 23 vessels, including six aircraft carriers, commanded by Vice Adm Chuichi Nagumo.

The IJN used three types of aircraft for the Hawaiian operation: Nakajima Type 97s (for level bombing and torpedo attacks), Aichi Type 99 dive bombers, and A6M2b Mitsubishi Zeros as fighter escorts. The Zero models were Mitsubishi-built Model 21 variants with manually folding wing tips. Zeros also provided combat air patrols for the Japanese fleet during the attack.

The first wave included 43 Zeros led by Lt Cmdr Shigeru Itaya. He planned to send 45 fighters, but two Zeros

This A6M2b (tail code AI-154) flown by PO1 Takeshi Hinaro from the *Akagi* was the first Zero shot down by US forces. After being hit by antiaircraft fire, Hinaro's Zero slammed into a building on Fort Kamehameha, killing four soldiers. (NARA)



Second Lieutenant Phillip M. Rasmussen (USAAC) stands next to his heavily damaged Curtiss P-36A Hawk. The young officer was the first US pilot to bring down a Zero in air-to-air combat on December 7, 1941. Rasmussen's triumph was short-lived as he was attacked by two A6M2bs that put over 500 rounds into his aircraft. (DoD)

experienced mechanical issues before takeoff. The attack formation skirted around the western part of the island of Oahu, then split in two near Haleiwa. The fighters and dive bombers turned south for Wheeler while the torpedo bombers and level bombers flew for Pearl Harbor. The first wave attacking Wheeler faced no fighter opposition, so Lt Cmdr Itaya released his Zeros to strafe targets of opportunity with their 20mm cannons and 7.7mm machine guns. Itaya had planned to use his fighters in this role from the beginning; his Zeros were loaded with a mix of armor-piercing, tracer, and incendiary rounds to increase damage to ground targets. The fighters attacked Kaneohe Naval Air Station (NAS) and Hickam Field, while one lone Zero, flown by Lt Tadashi Kaneko, attacked Bellows Field. A group of 12 Boeing B-17 Flying Fortresses arrived over the island during the attack. Their scheduled arrival had unintentionally masked the Japanese attack on radar. The bombers (spaced minutes apart) were greeted by fighters. Only two of the 12 B-17s were destroyed, both of which were on the ground.

The pilots from the carrier *Akagi* claimed three aerial victories during the first wave (all three aircraft were civilian trainers, two destroyed and one damaged); however, three Zeros (one from the *Akagi* and two from the carrier *Kaga*) were lost to ground fire. The first Zero brought down by US forces was an A6M2b (tail code AI-154) flown by PO1 Takeshi Hinaro from the *Akagi* during the first wave. At 0810hrs Hinaro's Zero was hit by a combination of antiaircraft fire from the destroyer USS *Helms* and land-based antiaircraft fire. Hinaro slammed into a building on Fort Kamehameha, killing four soldiers. Zeros from the carrier *Soryu* had just strafed Naval Base Ewa and Barbers Point when they spotted a flight of US Navy scout bombers (Douglas SBDs from the USS *Enterprise*). The Zeros engaged the formation and claimed five Douglas SBDs (US Navy records report four SBDs lost to air-to-air combat, one to friendly antiaircraft artillery, or AAA).

Lt Saburo Shindo led 36 Zeros from the various carriers during the second wave. Finding no aerial opposition, he released his fighters to attack preplanned targets. Nine Zeros led by Shindo strafed Kaneohe NAS, Hickam Field, and finally Pearl Harbor before heading back to the *Akagi* unscathed. As Zeros from the *Soryu* finished attacking Kaneohe NAS, one was hit by AAA. The pilot, Lt Fusata Iida, purposely dove his aircraft and crashed between two hangars at Kaneohe.

At 0850hrs, as the *Soryu*'s fighters formed up to return to the carrier, they were surprised by several Curtiss P-36 Hawks. The lead American pilot, 1st Lt Lewis M. Sanders, shot down a Val and turned to see 2nd Lt Gordon H. Sterling's P-36 trailing a Zero in a dive, with another enemy fighter in pursuit. A third P-36, flown by Second Lt Phillip M. Rasmussen, prepared to enter the dogfight and charged his guns. The guns went off fortuitously as a Zero passed in front of him, exploding the fighter. This was the first Zero brought down in air-to-air combat by the United States. The A6M being chased by Lt Sterling plunged into the water, followed by Sterling's P-36, which was being shot at by Lt Iyozo Fujita. Fujita's Zero was hit by Sanders, but he managed to evade and then attacked Second Lt Rasmussen. As Rasmussen dodged Fujita's attack, he raked another fighter before taking hits from two Zeros. His canopy was shot off, his hydraulic lines were severed, and his rudder and tail wheel were shot to pieces. Rasmussen temporarily lost control of his aircraft but eventually managed to steer into low clouds and land his damaged Hawk at Wheeler.

An A6M2b on display at the Pacific Aviation Museum, Pearl Harbor, Hawaii. The aircraft is painted in the markings of A1C Shigenori Nishikaichi (tail code BII-120) assigned to the IJN carrier *Hiryu* during the attack on Pearl Harbor. Pieces from Nishikaichi's actual aircraft (manufacturer number 2266) are on display next to this exhibit.

A formation of nine Zeros led by Lt Sumio Nono from the carrier *Hiryu* attacked Bellows Field. Two Curtiss P-40 pilots from the 44th Pursuit Squadron took off in response. Second Lt George A. Whiteman was shot down and killed shortly after his P-40 cleared the ground, and a Zero brought down Lt Samuel W. Bishop just off the coast at Bellows. Lt Bishop survived and swam back to shore.

In all, nine Zeros were lost during the Hawaiian operation. American forces lost eight military aircraft (four US Army Air Corps / four US Navy) and two civilian planes in the air, while hundreds of aircraft were destroyed on the ground.

Niihau incident

During the second wave of the Pearl Harbor attack, A1C Shigenori Nishikaichi's Zero (assigned to the *Hiryu*) was hit by a P-36. It became apparent that his damaged aircraft would not make it back to the carrier. He diverted for Niihau Island, a preplanned area for Japanese aviators in distress. Japanese intelligence mistakenly believed Niihau to be uninhabited. Upon landing, Nishikaichi's Zero hit a wire fence and crashed; Nishikaichi slammed into his instrument panel and was rendered unconscious. He was found by local resident Howard Kaleohano, who seized his weapon and personal papers. The inhabitants of the island were not yet aware of the attack on Oahu. Not speaking Japanese, Mr Kaleohano asked Mr Yoshio Harada and his wife to translate. The pilot told the couple about the attack, but the Haradas kept the pilot's story to themselves.

The islanders treated the pilot to a luau; however, the mood changed when word of the attack reached the island. Nishikaichi, now being guarded, managed to escape with the help of the Haradas, who had acquired a pistol and a shotgun. Now armed, they went to Kaleohano's house looking for the pilot's papers, but found nothing. They then went to the grounded Zero and tried to radio for help. Harada later encountered Kaleohano and shot at him. Fleeing, Kaleohano informed other residents about what had happened and then, joined by five others, rowed for ten hours to reach Kauai to alert the authorities.

Meanwhile, Nishikaichi removed a Type 97 7.7mm machine gun from his plane and then set the Zero on fire. The Japanese pilot confronted the local residents and demanded that they bring Kaleohano to him. One of the prisoners, Mr Ben Kanahele, lunged at Nishikaichi. The pilot shot Kanahele three times, but the Hawaiian pressed the attack, threw Nishikaichi against a wall, drew a hunting knife, and slit his throat. Harada, who had a shotgun in his hands, turned it on himself and committed suicide. Some historians believe that this event, which became known as the "Niihau incident," had resonating effects in terms of the internment of Japanese Americans.

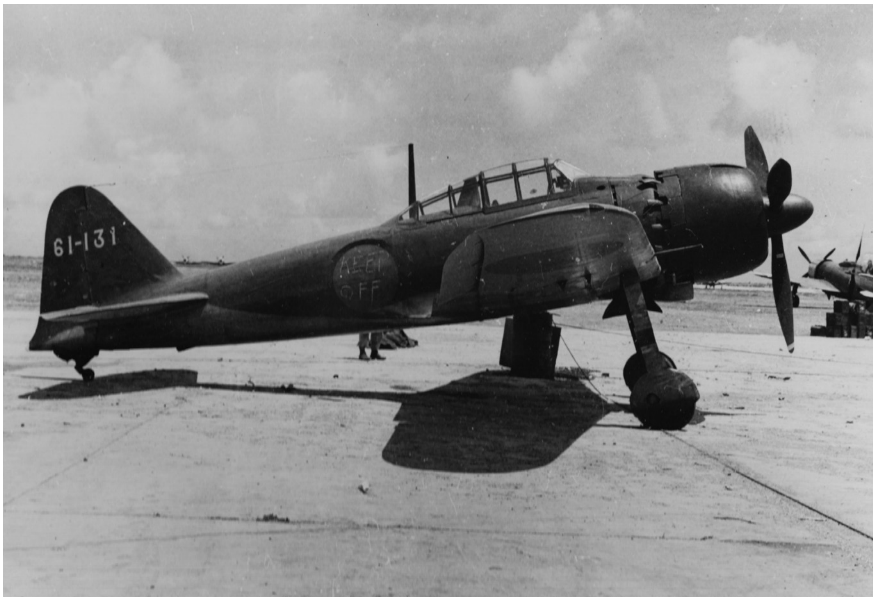
Zeros over Hawaii

IJN carriers	Tail codes	Zero fighters 1st/2nd wave	Zeros lost 1st/2nd wave
Akagi (1st Carrier Division)	AI	9/9	1/0
Kaga (1st Carrier Division)	AII	9/9	2/2
Soryu (2nd Carrier Division)	BI	8/9	0/3
Hiryu (2nd Carrier Division)	BII	6/9	0/1
Zuikaku (5th Carrier Division)	EII	6/0 CAP	0
Shokaku (5th Carrier Division)	EI	6/0 CAP	0
Totals:		44/36 80 total launched	3/6 9 lost

Land-based Zeros: the Philippines and Malaya

Philippines

Both the Imperial Japanese Army Air Force (IJAAF) and the IJN took part in attacking American bases in the Philippines just hours after the Hawaiian operation started. The IJAAF's fighters had insufficient range to escort bombers to Luzon from their bases in Formosa (a 900-mile round-trip); only one fighter, the IJN's Zero, could escort bombers that distance. Initially the IJN planned on utilizing carriers for the attack on the Philippines to limit the time spent in the air by the escorting fighter pilots. The carriers *Ryujo*, *Zuiho*, and *Kasuga-Maru* were deployed to Formosa, as were Zeros from the Tainan Kokutai and 3rd Kokutai. The Tainan Kokutai was led by Capt Masahisa Saito, and the 3rd Kokutai by Capt Yoshio Kamei. Both units boasted some of the most experienced fighter pilots from combat over China. The Zero crews trained



A captured Nakajima Works A6M5 assigned to the 261st Kokutai. The words "keep off" have been written inside the roundel/*hinomaru* to stop souvenir hunters. Nakajima began painting their Zeros with a demarcation line that rose to the front of the horizontal stabilizer. (NARA) relentlessly on fuel conservation and in developing the most effective formations to extend the range of their fighters. Their long-distance training flights would often surpass ten hours. Their tenacity and discipline paid off, eliminating the need for the carriers and allowing the vessels to be deployed elsewhere.

On the morning of the attack, the mission was delayed due to heavy fog. This first attack by IJAAF bombers was detected by the United States who scrambled both their fighters and their bombers (the US bomber force was ordered to take off to prevent them from being caught on the ground). After the fog cleared, the Tainan Kokutai launched 44 A6M2b fighters and the 3rd Kokutai launched 53. After the formation was reported at 1145hrs, US fighters were scrambled from Del Carmen to cover Clark Field but failed to arrive before the attack. The A6M2b fighters and IJN G4M Rikko (codenamed "Betty") bombers achieved complete surprise as they attacked Clark Field. The American B-17 bombers were lined up and being armed for an attack against Formosa; the fighters were preparing for takeoff after being refueled.

The Betty bombers, in a V formation, released their payloads from over 20,000ft. Once the Zeros were cleared from top cover duties, they attacked the B-17s and fighters on the ground. American antiaircraft fire proved ineffective; however, three P-40s from the 20th Pursuit Squadron managed to take off amidst the turmoil and claim three fighters. The Curtiss P-40s originally scrambled to search for the IJAAF formation were running low on fuel but managed to engage Zeros strafing Iba Field. In all, the Zeros from both Kokutais claimed nine air-to-air kills, at the cost of five A6M2bs.

The Far East Air Force's strength in the Philippines was in shambles: 18 of the 35 B-17 Fortresses assigned, as well as 53 P-40s and three P-35s, were destroyed. The Japanese naval aviators had pulled off an astonishing feat, given that US forces in the Philippines had learned about the attack on Pearl Harbor hours earlier. On December 10, the Japanese attacked Del Carmen, Nichols Field, and Cavite Naval Base, facing minimal air opposition. Zero pilots from the Tainan Kokutai (one of whom was Saburo Sakai) downed a B-17 piloted by Capt Collin Kelly. By December 15, the Far East Air Force consisted of only a handful of planes. Most of the Allied fighter pilots were forced to become infantrymen.

Land-based Zero unit designations: Numbered Kokutai
1/2/3/4/5/6/12/13/14/15/131/153/201/202/203/204/205/210/221/251/252/253/254/256/261/263/265/281/301/302/312/321/331/332/341/343/345/352/361/381/452/453/501/582/601/634/652/653/721/751/802/902/934
Note: Most units had a mix of aircraft.
Note: The IJNAF changed its unit designations to a three digit system on November 1, 1942, for land-based units serving outside of Japan. Under this system earlier numbered Kokutai and named Kokutai were re-designated (for instance the 3rd Kokutai became the 201st and the Tainan Kokutai became the 251st).

Malaya

The 22nd Air Flotilla was moved to bases in French Indochina to provide support for the IJA's invasion of Malaya. On December 6 the unit began patrol operations in search of Royal Navy shipping, including two capital ships (HMS *Repulse* and HMS *Prince of Wales*). On December 8, Singapore was bombed and Zeros claimed a single Bristol Blenheim over Singora; one A6M was lost (the pilot survived). On December 10 the *Repulse* and *Prince of Wales* were sunk by IJNAF aircraft, eliminating the biggest threat to the IJA's invasion of Malaya. On December 22, Zero pilots claimed three additional Blenheims. By late December, Zeros were being based inside Malaya, at Kota Bharu.

This heavily damaged Grumman TBF-1 Avenger was the lone survivor from Torpedo Squadron Eight (VT-8) during the Battle of Midway, June 4, 1942. The aircraft was part of a six-plane detachment on Midway. The rest of the squadron flew Douglas TBD Devastators from USS *Hornet* during the battle. Five of the Avengers were shot down, with all 15 of the squadron's TBDs destroyed that day. (USN)

IJNAF daylight air raids over Singapore began on January 12, 1942, with Zero escorts. During the campaign, the Zeros were opposed by British and New Zealand pilots flying Brewster Buffaloes and, later, Hawker Hurricane MK IIs. The Hurricanes, rushed to the theater in January, failed to stop the A6Ms from gaining complete air superiority. Japanese forces claimed 40 aerial victories during the campaign, at the cost of two Zeros.

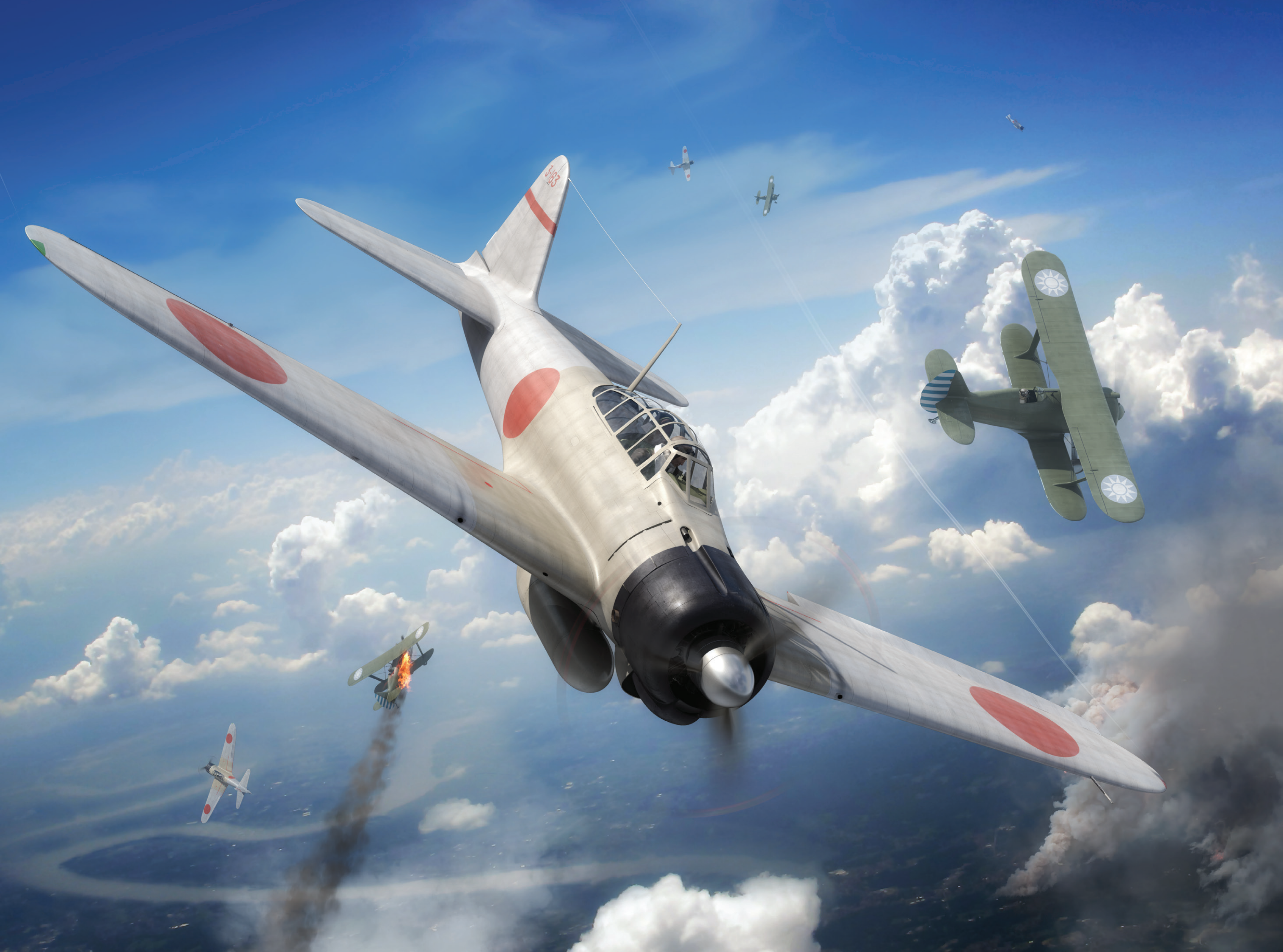
Wake Island

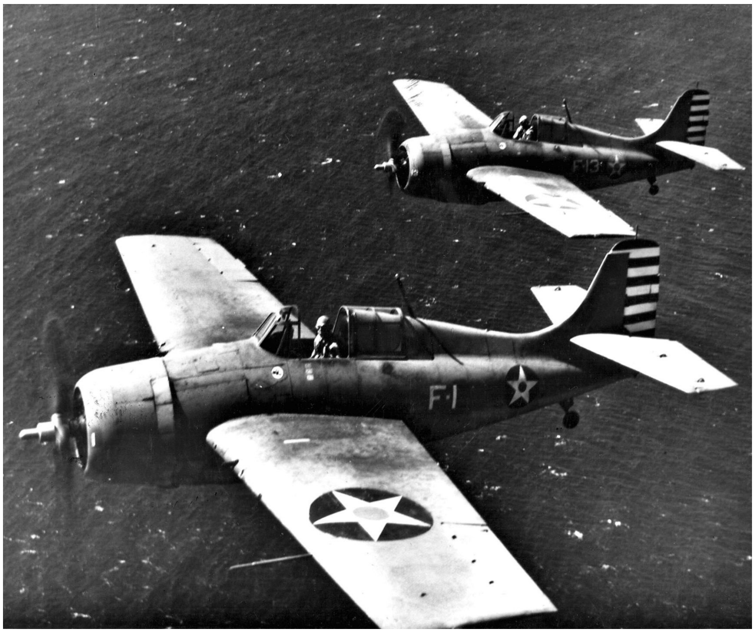
Americans stationed on Wake Island put up a gallant effort to stop the Japanese advance. The IJN initially sent bombers to soften up the island without fighter escort. For three days, the bombers were met with intense AAA and a small but determined fighter force of a handful of Grumman F4F Wildcats flown by Marines of VMF-211. The Wildcats also caused considerable damage to two light cruisers and sank the IJN destroyer *Kisaragi*. A Japanese invasion force attempted to land on December 11, 1941. Gunfire from the island and the few remaining Wildcats successfully repelled the force, damaged two light cruisers and sank the destroyer *Kisaragi* in the process. For the first time in their Pacific advance, the Japanese retreated.

E

BAPTISM OF FIRE

Mitsubishi Works A6M2 Model 11, 12th Kokutai, NAP2/C Tsutomu Iwai, Hankow AB, China, September 13, 1940. A Chinese Nationalist Air Force Polikarpov I-15bis attempts to evade Japan's newest entry into the Second Sino-Japanese War, the Mitsubishi A6M2 Type 0 Mark 1 carrier-fighter. The Imperial Japanese Navy hurried their new Zero fighter into theater for experimental combat trials, assigned to the 12th Kokutai (Naval Air Group) based at Hankow, China. In the knowledge that these aircraft were destined to operate from air bases deep within China, the A6M2s were not equipped with arresting hooks or radio homing devices for carrier operations. The first combat mission was flown on August 19, 1940, when Zeros escorted 50 G3M bombers to their target, Chungking, and back, but the Zeros faced no fighter opposition. On September 13, 1940, 13 Zeros from the 12th Kokutai were flying escort for G3M bombers; the bombers completed their bombing run over Chungking, and the Zeros headed back with them. A Japanese reconnaissance plane reported fighters over the city; the Zeros turned back towards Chungking and found over 30 Chinese fighters (I-15s and I-16s). The Zeros, led by Lt Saburo Shindo, decimated the enemy force, claiming 27 enemy fighters (Chinese Nationalist Air Force reported 13 losses that day) without a loss of their own (three Zeros were damaged). NAP2/C Tsutomu Iwai, flying 3-163, claimed two Chinese fighters; he was bettered by WO Koshiro Yamashita, who claimed five enemy aircraft, becoming the first Zero ace.


3-163



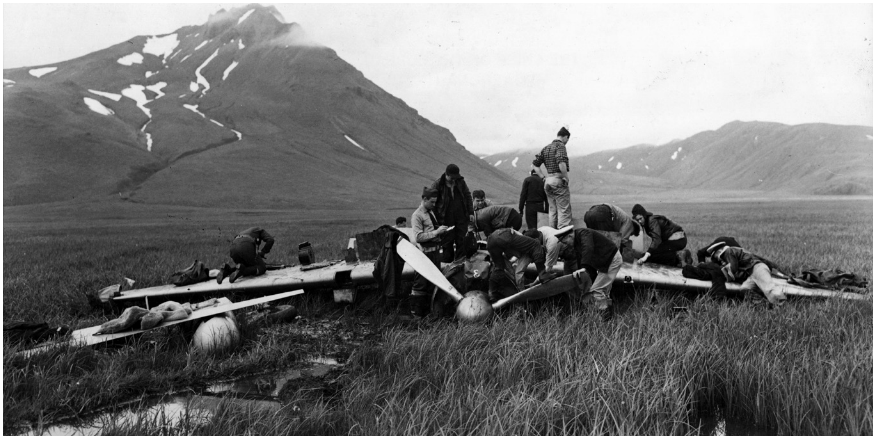
A pair of F4F Wildcats flown by Lieutenant Commander John Thach, the squadron commander of VF-3, and Lieutenant Commander Edward H. O'Hare, April 1942. Thach was instrumental in implementing the "beam defense" later known as the Thach Weave. This (two-ship) tactic using mutual support helped to counter the Zeros' superior maneuverability.

The second carrier division (returning from Pearl Harbor) was called in, bringing the carriers *Hiryu* and *Soryu* with their Zero fighters. With only two F4Fs available, the Marines continued to fight, making an effort to evade the Zeros and go after the bombers. They destroyed two bombers before one Wildcat was shot down by a Zero, while the other F4F crash landed back on Wake. The Marines, who had managed to operate what few planes they could by cannibalizing anything available, had no planes left. With air superiority gained over the island, the Japanese finally captured Wake.

Coral Sea and Midway

On May 7, 1942, the first carrier-versus-carrier battle in history commenced. Unknown to the Japanese at the time, the Allies had broken their JN-25 code. Aircraft from the *Shokaku* and *Zuikaku* launched to find an American carrier reported by a Kate bomber at 0532hrs. A total of 18 Zeros escorted an attack force of torpedo and dive bombers. They found only a tanker and its destroyer escort. As these were the only targets in the area, the Japanese attacked, sinking both vessels. Soon after, the Japanese light carrier *Shoho*, shielding the Port Moresby invasion force, reported a large number of enemy aircraft approaching. The enemy aircraft overwhelmed the six Zeros and two A5M Claudes flying combat air patrol (CAP); the *Shoho* was the first Japanese carrier lost during the war.

The loss of the *Shoho* forced the Japanese to postpone the invasion of Port Moresby (Operation *MO*). Aircraft from the *Shokaku* and *Zuikaku* launched a second time at 1430hrs, knowing they would return to their carriers after dark. This time the Zeros would not accompany the attack force, as they were not equipped for night operations. Wildcats found the attack force without their typical fighter escorts; they downed eight of the 15 torpedo bombers and one dive bomber. The next day, the aviators of the *Shokaku* and *Zuikaku* wanted redemption. After two US carriers were spotted, the attack force launched, escorted by 18 Zeros. The force hit the USS *Lexington* (which later had to be scuttled) and the USS *Yorktown*. Nonetheless, the Japanese attack came too late, as American carriers had already launched their attack. The *Shokaku* was so badly damaged that it could no longer launch or recover aircraft; the *Zuikaku* fared better as the ship was shielded by weather. The losses in aircraft increased when the captain of the *Zuikaku* was forced to push aircraft off his deck to make room to recover the *Shokaku*'s aircraft. Although Operation *MO* can be considered a statistical victory for the IJN, the Allies stopped the Japanese advance and forced the IJN to abandon their invasion of Port Moresby. It also prevented



One of the most important prizes of the Pacific War was this Mitsubishi Works A6M2b found by a USN PBY Catalina crew on July 10, 1942. The Zero (manufacturer number 4593) crash-landed on Akutan Island after being hit by ground fire during an attack on Dutch Harbor, Alaska, on June 4, 1942. The photograph shows the ruts the Zero's gear made before flipping over on its back, killing the pilot, PO1/c Tadayoshi Koga. (NARA)

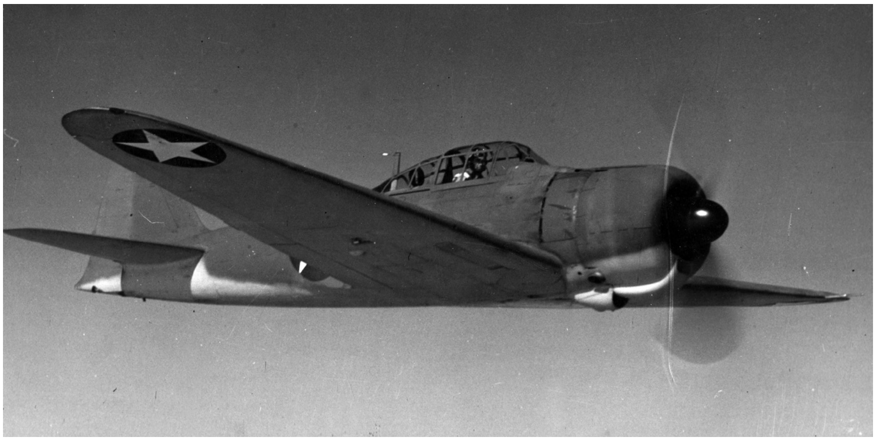
the *Shokaku* and *Zuikaku* from taking part in the Battle of Midway one month later.

The initial attack launched against Midway Atoll, Eastern Island, included over 70 attack aircraft escorted by 36 Zeros from the carriers *Akagi*, *Hiryu*, and *Kaga*. After the Japanese attack force was detected by radar, a detachment of Grumman TBF Avengers from VT-8 and USAAF bombers launched from Midway. This was followed by fighters of VMF-221 and attack aircraft (Douglas SBDs and Vought SB2Us) of VMSB-241. The Japanese attack force was 30 miles from Midway when it came under attack from Marine aviators of VMF-221 flying Brewster F2A-3 Buffaloes and Grumman F4F Wildcats. The Zeros, led by Lt Masaharu Suganami, were at a slightly lower altitude than the Vals and Kates when the fight erupted. With their initial altitude advantage, the Buffaloes and Wildcats destroyed two Kates, one Val, and two Zeros above Midway. However, by the end of the melee, VMF-221 was devastated: Suganami's Zeros had killed 15 of the 25 pilots assigned to VMF-221, including the squadron commander, Maj Floyd Parks. Surviving pilot Capt Philip R. White later lamented: "It is my belief that any commander who orders pilots out for combat in a F2A should consider the pilot as lost before leaving the ground."

VT-8's detachment of TBFs arrived at the Japanese fleet, without fighter protection, at 0710hrs. Of the six Navy TBFs launched from Midway that day only one survived. The Marine Douglas SBD Dauntlesses and Vought SB2U Vindicators that launched from Midway met a similar fate from Zeros and antiaircraft fire without inflicting major damage to the Japanese task force. The US carrier attack groups followed, but their outdated TBD Douglas Devastators were ripped to shreds by the Zero combat air patrols during their vulnerable low-level torpedo runs. VT-8 lost all 15 TBDs. The Zeros were out of position to handle the greatest threat, Douglas SBD Dauntless dive bombers. Three squadrons of SBDs making their dives from high altitude inflicted fatal damage to the carriers *Kaga*, *Akagi*, and *Soryu*. The carrier *Hiryo* recovered some A6Ms that were airborne from other carriers, but was itself mortally hit by SBDs later in the fight. Nonetheless, *Hiryo* aircraft fatally wounded the USS *Yorktown*.

Aleutians

On June 3, 1942, Adm Kakuji Kakuda's 2nd Carrier Task Force (built around the carriers *Junyo* and *Ryujo*) attacked Dutch Harbor in the Aleutian Islands of Alaska. This diversionary attack, designed to draw the American fleet away



PO1/c Tadayoshi Koga's Zero was rebuilt and painted in a US naval color scheme at NAS San Diego prior to testing. Lieutenant Commander Eddie R. Sanders flew the first test flight on September 20, 1942. Koga's Zero was instrumental in revealing methods to counter the seemingly invincible Mitsubishi fighter. (NARA)

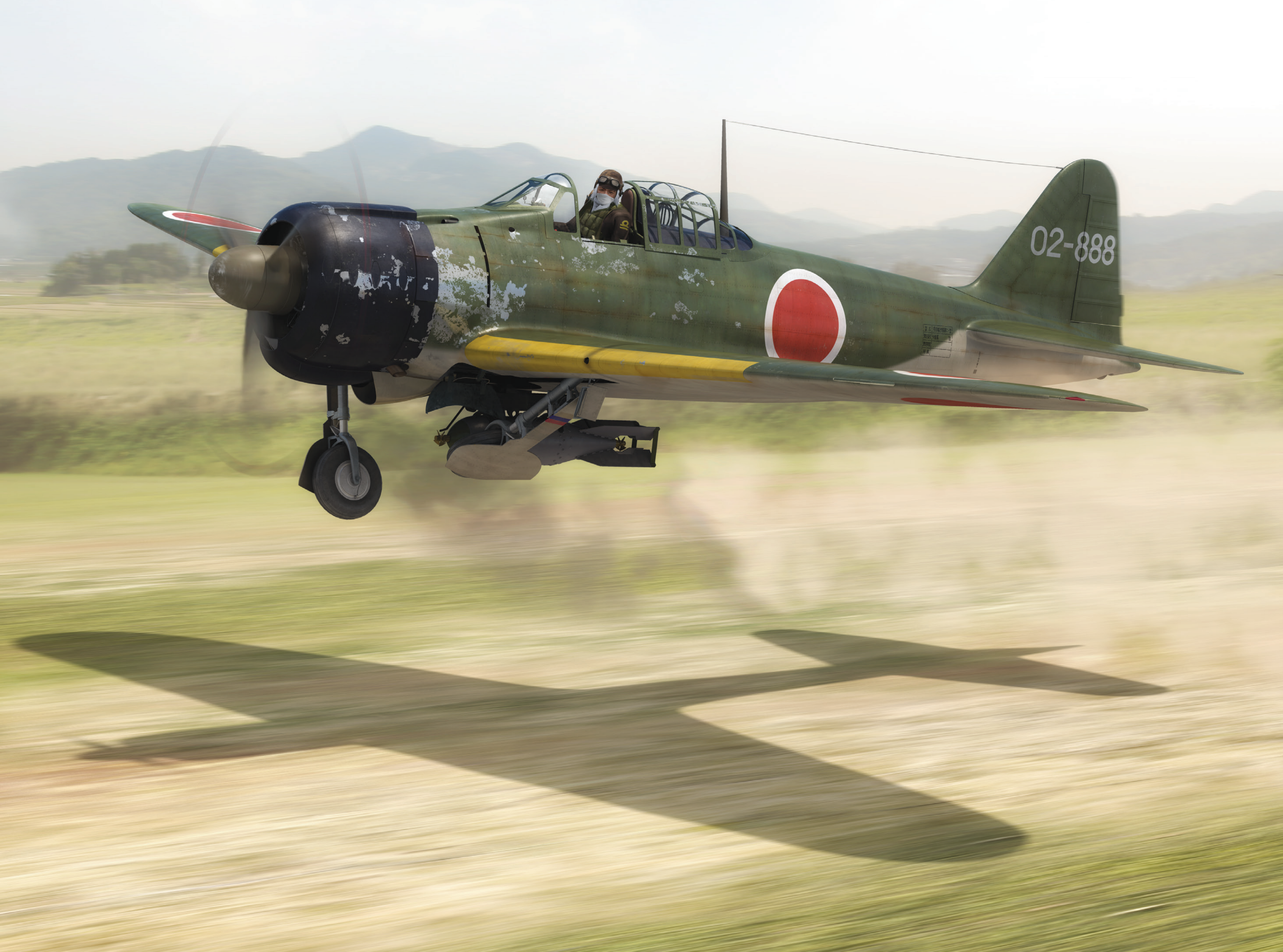
from Midway, would have unforeseen consequences for the IJN in future battles. A second attack followed on June 4. During this attack, antiaircraft fire hit the A6M2b Zero flown by Tadayoshi Koga over Dutch Harbor. The aircraft's return oil line was severed, forcing the pilot to Akutan Island, a pre-designated area for an emergency landing. The flat grassy area that appeared suitable for landing hid a soft layer of mud below the grass. Once his plane touched down, the main wheels sank quickly into the mud. The momentum flipped the Zero over. Two pilots from his three-plane section watched as his Zero nosed over onto the cockpit. Neither pilot could tell if Koga was still alive within the wreckage, and they could not bring themselves to destroy the plane.

Koga's Zero was found by a US Navy Consolidated PBY Catalina crew on July 10. When American service members inspected the plane they found Koga's body still strapped into his seat. The aircraft, built by Mitsubishi in Nagoya in February of 1942 (manufacturer number 4593), had suffered some minor damage during the crash. After its recovery, it was immediately shipped to NAS San Diego for repair and flight testing. During the tests, officials found that the Zero's amazing lateral maneuverability decreased dramatically at higher speeds. It also lacked high-altitude performance and diving speed.

F

Nakajima Works A6M2 Model 21 (02-888) (Fighter-Bomber/*Bakusen*), Lt Yukio Seki, "Shikishima-Tai" Special Attack Unit, Mabalacat, Philippines, October 25, 1944.

Lt Yukio Seki lifts his Model 21 fighter-bomber off the strip at Mabalacat Airfield, Philippines, in search of the US Naval fleet over Leyte Gulf. Lt Seki led the "Shikishima-Tai," the first official kamikaze Special Attack unit. His group comprised a mix of Zero models. Lt Seki flew an older Model 21 fighter-bomber with a centerline bomb rack carrying a 250kg bomb. His formation found Taffy 3 (Task Unit 77.4.3), an escort carrier unit which comprised escort carriers, destroyers, and destroyer escorts. The ships of Taffy 3 had just seen action that morning, surviving against a superior Japanese surface fleet during what was to become known as the battle off Samar. Taffy 3 lost one destroyer and two destroyer escorts in the naval engagement. It was little over an hour after this surface engagement ended that the "Shikishima-Tai' Special Attack unit found Taffy 3 and commenced their suicide attack. At 1053hrs a Zero (some presume to be Seki's) released a 250kg bomb that penetrated the flight deck of the escort carrier USS *St Lo* (CVE-63). The Zero then crashed into the *St Lo*'s deck, hurtling off the end of the bow. Soon after, the *St Lo* experienced an explosion from within the ship's hangar deck, followed by a secondary explosion ripping up portions of the flight deck; multiple explosions followed. The captain ordered the ship's engines cut, and the crew was ordered to abandon ship soon after. The ship finally succumbed and went under at 1125hrs.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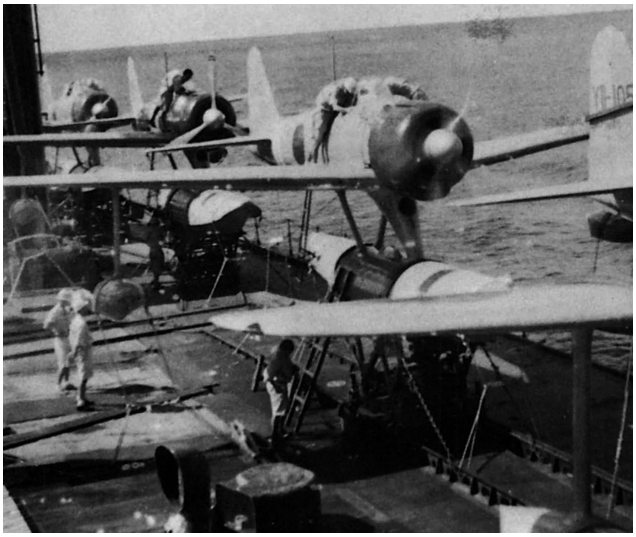


A group of A6M2-N, Type 2 float-fighters seen onboard the seaplane tender *Kimikawa-Maru*, August 1942. The A6M2-N was intended as an interim design, to be replaced by the Kawanishi N1K Kyofu float-fighter. (Maru)

Float-fighters in action

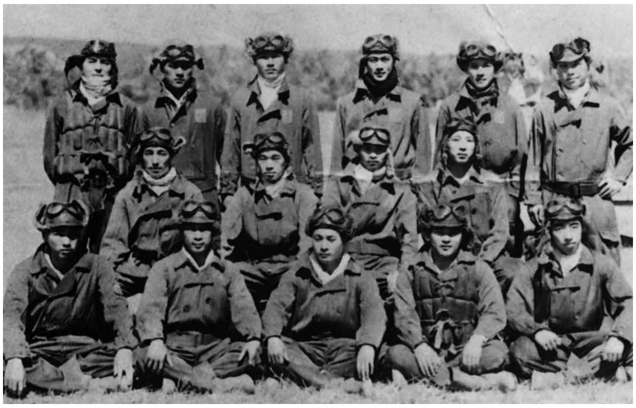
Soon after the attack on Dutch Harbor, Adm Kakuji Kakuda's two carriers turned back to Japan. Japanese forces occupied the islands of Attu and Kiska, and established a float-fighter base on Kiska on June 8. The A6M2-N was the only fighter capable of operating from the occupied islands, as no air strips had been built on either. One month later, on July 8, A6M2-N float-fighters of the Toko Kokutai (part of the 5th Kokutai – later renamed the 452nd) made their first intercept against B-24 Liberators. The first Allied fighter claimed by an A6M2-N was a Lockheed P-38 Lightning, on September 14, 1942. On the 15th, the float-fighters engaged a dozen bombers protected by fighter escorts. A pilot from the 5th Kokutai PO2c, Gi-ichi Sasaki, claimed four of the five aircraft shot down by the unit, becoming the highest scoring A6M2-N pilot.

The Japanese continued to send new A6M2-N aircraft into the theater via seaplane tenders like the *Kimikawa-Maru*. However, the numbers dwindled due to attrition caused by both Allied aircraft and the terrible sea and weather conditions. As the Allies moved on Amchitka Island, A6M2-Ns from the 452nd Kokutai utilized their float-fighters as fighter-bombers. The A6M2-Ns, loaded with 60kg bombs, conducted attacks against US shipping around the island of Amchitka. On February 19, during one of these attacks, Gi-ichi Sasaki was shot down and killed by a Curtiss P-40. In May the Allies landed on Attu and Kiska, ending the Japanese occupation. During nearly a year of operations, the A6M2-N pilots claimed 15 victories in air-to-air combat for the loss of 12 of their own. All of the 35 float-fighters deployed to the theater were destroyed, either by the Allies or by the weather.

Tainan Kokutai and Rabaul

The most successful Zero outfit during the war was the Tainan Kokutai, established on October 1, 1941, in Formosa (Taiwan), and commanded by Capt Masahisa Saito. Following their actions over the Philippines, the group operated from airstrips taken by Japanese forces, such as Jolo, Tarakan, and Balikpapan. The Tainan Kokutai fought for air superiority over the Dutch East Indies and Java. The group also had elements operating on Bali, Makassar, and Lae. Part of the Tainan group moved to Rabaul in April 1942 and operated over Eastern New Guinea; they racked up the lion's share of the unit's kills, claiming more than 300 air-to air kills (including intercepts from Rabaul), while losing only 20 of their own.

Enlisted pilots from the Tainan Kokutai at Rabaul 1942. From this unit rose some of the highest-scoring Zero aces of the war: PO/1c Hiroyoshi Nishizawa (top row far left), PO1/c Saburo Sakai (second row, second from the left), and PO2/c Toshio Ota (to the left of Sakai); by the end of the war the three had a combined total of 180+ kills. (Sakaida)



The Allied invasion of Guadalcanal expanded the Tainan Kokutai's operational area to the Solomon Islands, where it took on US Navy aircraft for the first time on August 7, 1942, claiming 36 kills (actual Allied losses numbered 11 aircraft). Prior to being renamed the 251st Kokutai in November 1942, the group claimed another 164 victories. The Tainan Kokutai produced the largest number of aces of any Zero group. The dogfights over Guadalcanal against the Cactus Air Force produced some of the most intense aerial fighting of the Pacific. Aces on both sides racked up their scores; many of these aces were also shot down, some on multiple occasions.

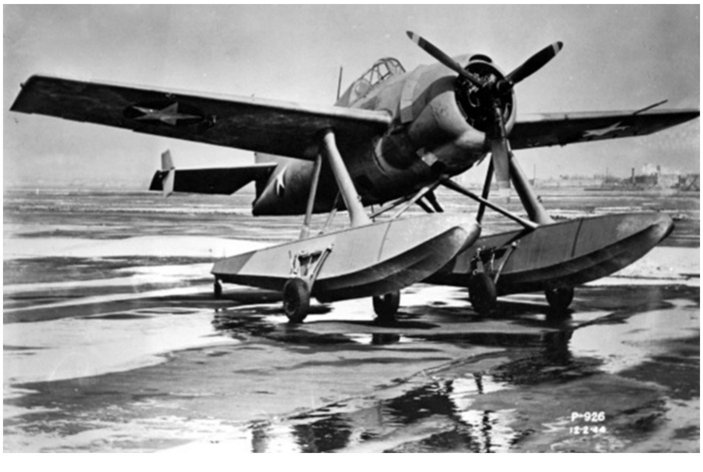
Attrition slowly devoured the unit while at Rabaul. Unlike their American counterparts, the Japanese had no tour limits for pilots, keeping irreplaceable veteran pilots on the frontlines for extended periods. From August through October 1942 alone, more than 30 pilots were killed (including aces Junichi Sasai and Toshio Ota), and numerous others were wounded in action. In November the unit, with its few surviving members, was sent back to Japan to recoup.

Guadalcanal

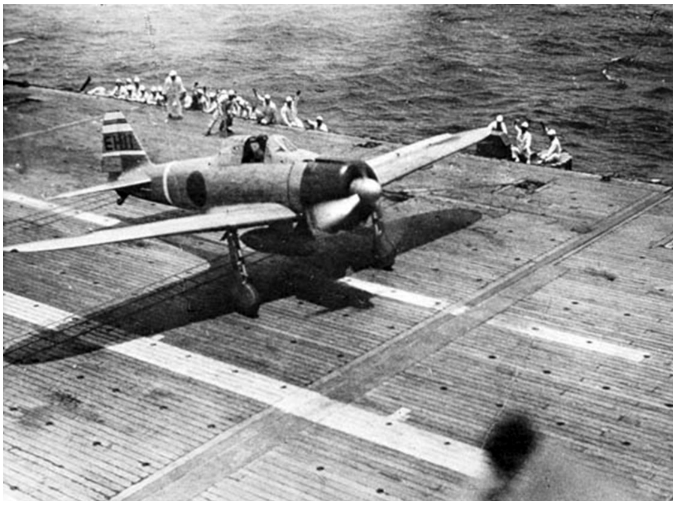
In July 1942, A6M2-N float-fighters assigned to the Yokohama Kokutai operating from Tulagi (Solomon Islands) began intercepting Allied bombers operating near Guadalcanal, where the Japanese were constructing airfields. The float-fighters claimed a B-24 on July 10, and several other aircraft in early August. The most spectacular victory happened on August 4 when an A6M2-N rammed a B-17. On August 7, 1942, the Yokohama Kokutai reported to IJN Headquarters that an Allied invasion fleet was off Guadalcanal. This was the last message received from the float-fighter unit. The Allies successfully invaded Guadalcanal, Tulagi, and the Florida Islands.

The IJN attempted to take back Guadalcanal for over seven months, leading to some of the greatest air battles over the Pacific. The opening day was no exception, as Zeros from the Tainan Kokutai from Rabaul escorted Betty bombers to attack Guadalcanal. Sixty American fighters met the formation. Although the Zero pilots claimed 36 aircraft, one of their leading aces, Saburo Sakai, received a head wound after mistaking an SBD for a Wildcat and was hit by the SBD's rear gunner. Sakai miraculously landed safely back at Rabaul, over 600 miles away. Nishizawa claimed six fighters that same day. Even though reinforcements from the 2nd Kokutai had arrived the day prior, this unit possessed the newest Zero variant, the A6M3 Model 32, which did not have the range to fly missions over Guadalcanal from Rabaul. This limitation would be the catalyst that forced Mitsubishi to produce the Model 22.

The Tainan Kokutai also received reinforcements from an unexpected source, after the carrier *Ryujo* was sunk during the battle of the Eastern Solomons on August 24, 1942. The *Ryujo*'s Zeros flying CAP were reassigned to Rabaul, while the other two carriers, the *Zuikaku* and *Shokaku*,



The A6M2-N float-fighter made such an impression on the US Navy that an attempt was made to create a counterpart utilizing the Grumman Wildcat, known as the F4F-3S Wildcatfish. (USN) delivered their fighters to Buka Island before departing for Japan. The fourth carrier-vs-carrier battle took place on October 26, 1942, as IJN carriers (*Zuikaku*, *Shokaku*, *Junyo* and *Zuiho*) attempted to stop the Allies from resupplying troops on Guadalcanal. The *Shokaku* launched its attack aircraft first at 0515hrs, followed by the *Zuiho*. Lt Commander Hideki Shingo led 27 Zeros to cover the *Shokaku*'s Vals and Kates, totaling 40 planes. A second attack group of 32 planes launched 45 minutes later from the *Zuikaku*, escorted by 16 Zeros led by Lt Kenjiro Nohtomi. As the *Shokaku*'s aircraft headed for their target they passed US Navy aircraft on their way to attack the Japanese ships. Shingo, commanding the Zero escort fighters, failed to recognize the formation, allowing the US planes to inflict heavy damage on the *Shokaku*. The Zeros from the *Zuiho* held off the American planes, allowing their own carrier to escape.



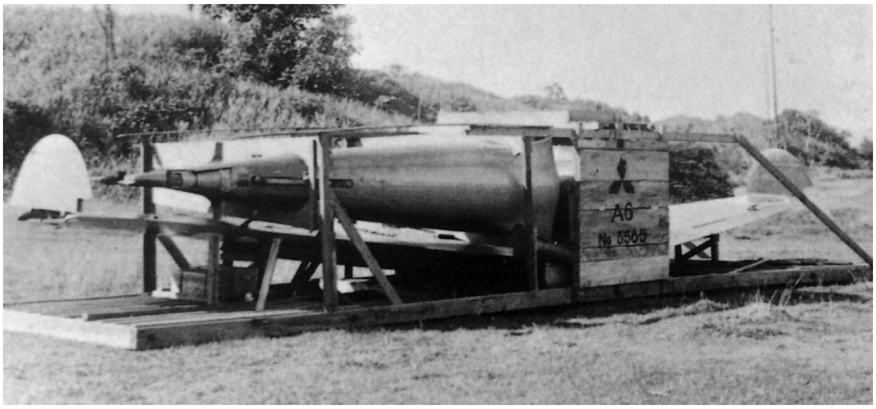
A Mitsubishi-Works A6M2b Zero (tail code EI-111) flown by Lt Hideki Shingo takes off from the IJN carrier *Shokaku* during the battle of Santa Cruz, October 26, 1942. (NARA)

The IJN attack aircraft found the USS *Hornet* and hit it with multiple torpedoes and bombs, crippling it. The USS *Enterprise* was hit by a second division launched from the *Zuikaku* and *Junyo*. It suffered three bomb hits, but evaded the torpedoes, before it got away. The *Hornet* was attacked a second time later that afternoon, sealing its fate (the *Hornet* was scuttled to prevent the ship falling into enemy hands).

After the defeats at Guadalcanal (and later the Bismarck Sea), Commander in Chief of the Combined Fleet Adm Yamamoto initiated Operation *I-Go* in April 1943, an attempt to regain air superiority over the Solomons and New Guinea by consolidating his land-based and carrier air groups, mostly at Rabaul. The first of the operation's four major raids took place on April 7, 1943, against Guadalcanal; the last one took place on April 14 over Milne Bay. On April 18, Adm Yamamoto was killed when Lockheed P-38 Lightnings ambushed the two Betty bombers transporting him and his staff from Rabaul to Buin. Yamamoto's fighter escort of only six Zeros failed to protect the Bettys and destroyed only one of the P-38s.

The Marianas Turkey Shoot

To defend the Marianas Islands against Allied invasion, the IJN deployed a Japanese carrier task force commanded by Vice Adm Jisaburo Ozawa that brought together nine Japanese aircraft carriers and 64 other vessels (including the battleships *Yamato* and *Musashi*). The result would be the battle of the Philippine Sea. The 1st Air Fleet, commanded by Vice Adm Kakuji Kakuda and headquartered on Tinian, had nearly 1,000 aircraft stationed in the Marianas, Truk, Carolines, and Iwo Jima. Both commanders were to coordinate their efforts in defense of the Marianas. As the Allies began bombarding the Marianas in mid-June 1944, Ozawa's fleet was ordered into battle by Adm Soemu Toyoda; by that time, Ozawa had ordered his fleet to refuel and would need a week before it could arrive in force. As a result, Kakuda's force had to stand on its own.



A brand-new Mitsubishi Works A6M3 Model 22 (manufacturer number 3585), palletized. The aircraft awaits construction after being delivered via ship to Rabaul East, 1943. (IJN)

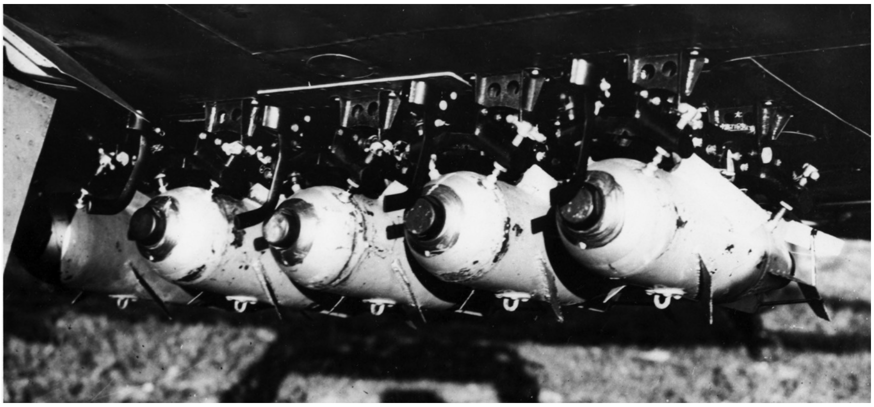
The 1st Air Fleet had the new Kawanishi N1K1-J Shiden fighter (Allied reporting name George). However, it suffered from teething issues, forcing the 1st Air Fleet to rely heavily on their Zeros when the fighting erupted. The 1st Air Fleet had both standard Zeros and fighter-bomber conversions. In order for Kakuda's aircraft to press their attack against the American task force his torpedo bombers and dive bombers had to pass a nearly impenetrable fighter screen of F6F Hellcats. For those who survived that onslaught, a barrage of AAA fire from the fleet awaited.

Kakuda's fighters had a difficult time defending their own base as Allied air strikes had destroyed most of their aircraft and installations. The shortage of veteran combat pilots and the lack of training among the new pilots were evident. On the opposition, the US Navy's F6F Hellcat completely outclassed the Zero. It seemed as if the roles had been reversed – the US Navy now had the more experienced, better trained pilots and superior equipment. The antiquated Zeros had lost air superiority prior to the Japanese fleet's arrival. The Japanese fighter force, mostly made up of Zeros, tried to fend off the Allied carrier force. They took a heavy toll, and air superiority over the Marianas was lost before Ozawa's fleet had even arrived.

The Japanese mobile fleet had nine carriers – three more than at Pearl – with a combined total of 450 aircraft. The IJN possessed Jill attack bombers, Judy dive bombers, and modified Zero fighter-bombers, but still relied on the A6M as its only carrier-fighter. On June 19, 1944, the air battle began after search aircraft found the US fleet (Task Force 58). Multiple waves of Zeros, Zero fighter-bombers, Suiseis, and Tenzans launched that morning. The first wave encountered Hellcats 70 miles from Task Force 58's position. As the Japanese attackers were picked up on radar 150 miles out, Hellcats were launched early *en masse* and took up an advantageous position. The Hellcats decimated wave after wave as they approached. During the attack some aircraft did break through; however, the most seriously damaged ship was the battleship USS *South Dakota*, and it still managed to escape under its own power.

Attack waves from the carriers *Junyo*, *Hiyo*, and *Ryujo* encountered foul weather, forcing the group to split: one group found the US fleet but lost most of their force, while the second group failed to find the US fleet and instead of flying back to their ships, headed for Guam (as they lacked the training to land on a carrier); they were confronted by Hellcats and lost 26 aircraft. Planes from the *Zuikaku* failed to find the US fleet before US fighters found them, destroying nine aircraft.

This A6M2b Zero has an experimental load of five Type 99 No 3 Mk 3 Mod 1 30kg air-to-air bombs, attached via small bomb racks on each wing. The small fins alongside the bomb's body helped accelerate the rotation of the bomb. Each bomb contained a central burster tube that would disperse 144 white phosphorus pellets.



The sailors aboard the Japanese carriers awaited retaliation from the American carriers, but US Navy attack aircraft never showed. Instead, the US fleet attacked from below. At 0816hrs, the submarine USS *Albacore* torpedoed Japan's newest carrier, the *Taiho*. The *Shokaku* was hit three hours after the *Taiho*; the culprit was another US submarine, the USS *Cavalla*. The two carriers sank ten minutes apart, the *Shokaku* going under first, taking 1,272 men with it.

The Japanese encountered Task Force 58 again on June 20. What little assets the IJN could muster were launched, but they failed to make contact with the enemy fleet, and every aircraft sent was lost. The TF-58 finally launched their own air strikes with over 230 aircraft. Only 35 Zero fighters mounted a defense. The outdated Zeros were overwhelmed as bomb-laden TBFs, SBDs, and Hellcats broke through and damaged four carriers (including the *Hiyo*), a cruiser, and a battleship. The IJN lost over 600 aircraft (land and carrier based) during the battle.

Desperation on Iwo

On July 4, 1944, the Kokutai commander on Iwo Jima, Capt Kanzo Miura, ordered his pilots to conduct suicide attacks against American ships. His group had been decimated by American airpower; at the time this decision was made, the unit had only nine Zeros and eight bombers left:

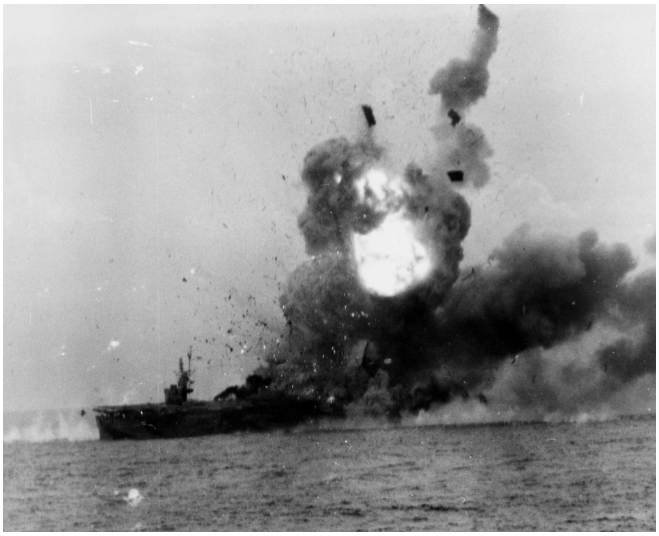
> Until you reach your targets, the fighter pilots will refuse to accept battle with the enemy planes. No bomber pilot will release his torpedo in an air drop. No matter what happens you will keep your planes together, wing to wing. No obstacle is to stop you from carrying out your mission. You must make your dives in a group in order to be effective. I know that what I tell you to do is difficult, it may even seem impossible. But I trust that you could do it, that you will do it. That every man among you will plunge directly into an enemy carrier and sink the vessel.

One pilot who received this order was ace Saburo Sakai. In his book *Samurai*, Sakai described the surreal situation on the ground prior to the mission. The men chosen for the attack packed their personal belongings for shipment back to their families, while comrades shared cigarettes, food, and other items that were in short supply on the island. Patriotic banners had been displayed for days prior to inspire the wing. Sakai felt that the propaganda was a sign of weakness, and had never been needed earlier in the war. Kaneyoshi Muto, another ace selected for the suicide mission, tried to lighten the mood by cracking some jokes before takeoff. The formation made their way toward the US fleet, nearly 400 miles from Iwo, giving them all time to deliberate on their assignment. Their aircraft were picked up by the fleet's radar and a wall of Hellcats intercepted the Japanese formation before the fleet was ever sighted. Outnumbered, the Zeros tried desperately to stick to their orders and not leave the bombers. The Hellcat pilots had other plans, diving into their formation and annihilating seven of the bombers in a matter of minutes. After Sakai's V formation was jumped by a group of Hellcats, he disregarded orders and fought his way out. His two wingmen followed, and during the battle Sakai shot down one Hellcat. Perhaps more impressively, he and both of his wingmen evaded the Hellcats by finding cover in some clouds.

With the Hellcats gone and the weather turning on them, they continued to look for the US fleet. Encroaching thunderstorms made it impossible to continue, forcing Sakai to make a choice: go back to Iwo in dishonor for disobeying a direct order, or plunge into the ocean with his two wingmen. He decided to head back to Iwo, and incredibly found the tiny island after dark. Holding his head in shame, he made his way to the command post where he found fellow Zero pilot Kaneyoshi Muto who had led another formation on the mission. Muto, in shambles, noticed that Sakai had managed to save his wingmen as well. Sakai was able to help Muto collect himself as the two men walked into the command post together to face their punishment for surviving. The commander heard their stories and dismissed them without punishment. One of the bombers returned as well, all that was left of the eight that had taken off.

The Zero and the Divine Wind

After the failure of the battle of the Philippine Sea, the IJN officially adopted the tactic of deliberate mass suicide attacks in a desperate attempt to halt the invasion of the Philippines. It was fitting that the Mitsubishi Zero, a defining aircraft at the beginning of the war, would play the leading role at such a desperate time. The Zero's mass availability made it a clear candidate for the job. The latest models provided fighter escort for Zero *Bakusen* fighter-bombers (both A6M2b and A6M5 variants). The Zero fighter-bombers were considered the most accurate dive bombers in the IJN at the time and had enough performance to break through the Allied combat air patrols protecting the fleet. Armed with a single 250kg bomb on a centerline rack, this meager force of Zeros available in the Philippines would have a devastating effect. Commander of the 1st Air Fleet Vice Adm Takijiro Onishi, who had originally rejected the notion of suicide attacks, now saw little choice in the matter. After arriving in the Philippines he expressed his views to his men: "In my opinion, there is only one way of assuring that our meager strength will be effective to a maximum degree. That is to organize suicide attack units composed of A6M Zero fighters armed with 250-kilogram bombs, with each plane to crash-dive into an enemy carrier." Many of the fighter pilots were taken by surprise; these men had been facing tremendous odds in air-to-air combat just to survive



The USS *St Lo* (CVE-63) seen shortly after being struck by a single A6M2b fighter-bomber. The Zero's 250kg bomb was released seconds prior to the aircraft slamming into the ship's deck. The bomb penetrated the flight deck, causing secondary explosions in the hangar bay, October 25, 1944. (USN)

A Nakajima Works A6M5 *Bakusen* (fighter-bomber) seen loaded with a 500kg bomb on a centerline bomb rack. The pilot assigned to the Special Attack unit prepares for takeoff at Mabalacat Airfield, Philippines, October or November 1944. (NARA)

thus far, now to face no chance of survival. Others expressed a willingness to go, as they had been watching their fellow pilots fall one after another in a losing defensive strategy. Yukio Seki (who led the first successful attack) was at first honored to be selected for the mission, but when interviewed before the mission said the following: "Japan's future is bleak if it is forced to kill one of its best pilots. I am not going on this mission for the Emperor or for the Empire … I am going because I was ordered to!"

The first missions attempted by the Special Attack unit took place on October 21 and 23, 1944. On both occasions they failed to locate American carriers. On the 25th, Lt Yukio Seki led a group of Zeros to search for the American fleet. The kamikaze pilots flew fighter-bomber versions of the Zero, with a single 250kg bomb-loaded centerline. These aircraft were supported by Zeros flying escort, which also served to report back with damage assessments. The formation found Taffy 2 and Taffy 3 of Task Unit 77.4.3. The ships had just seen action that morning, surviving an engagement against a superior Japanese surface fleet at the battle off Samar. It was little over an hour after this surface engagement ended that the "Shikishima-Tai" Special Attack unit found Taffy 3 and commenced their suicide attack. At 1053hrs, a Zero (which some presume to be Seki's) released a 250kg bomb that penetrated the flight deck of the escort carrier USS *St Lo* (CVE-63). The Zero then crashed into the *St Lo*'s deck, hurtling off the end of the bow. The attack triggered an explosion from within the ship's hangar deck followed by a secondary explosion that ripped up portions of the flight deck; multiple explosions followed. The captain ordered the ship's engines cut and the crew was ordered to abandon ship soon after. The *St Lo* finally succumbed and sank at 1125hrs.

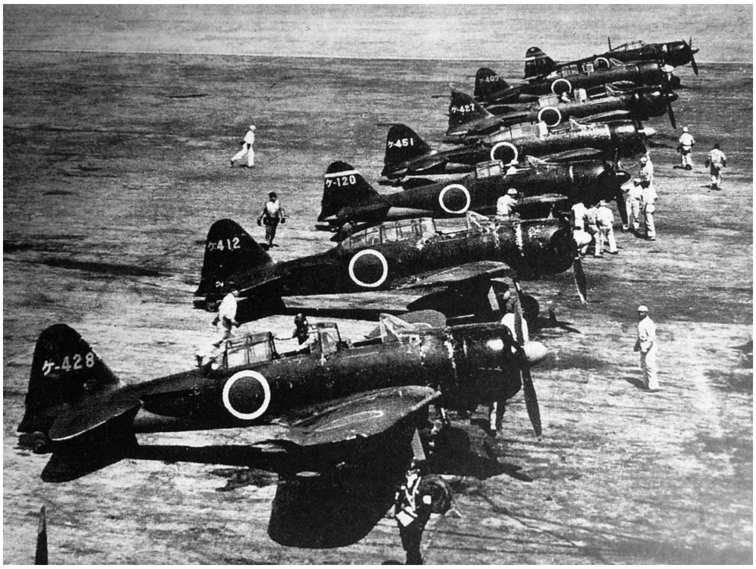
Multiple escort carriers were damaged by other kamikazes during the attack, including the *Kalinin Bay*, *Kitkun Bay*, *Santee*, and *Suwanee*. The Japanese escort pilots, one of which was leading ace WO Hiroyoshi Nishizawa, reported the success of the mission. Adm Onishi's 1st Air Fleet's success had a reverberating effect for both the IJN and IJAAF and kamikaze missions soon became a standard strategy in attacking the vulnerable Allied fleets. Onishi decided to use other aircraft as well, as the Zero fighter-bombers carried a limited payload (250kg). The fighter-bomber version of the A6M5 could carry a 500kg bomb. Still, Zeros made up nearly 80 percent of all aircraft used as suicide aircraft in the Philippines. In four months kamikazes damaged or sank over 50 ships.

The success of suicide missions in the Philippines led to kamikaze tactics against American ships at Iwo Jima and Okinawa in 1945. On April 6, the first of ten operations (known as the Kikusui raids) began in an attempt to drive away Allied forces invading Okinawa. These coordinated mass attacks using both IJN and IJAAF aircraft made it impossible for the Corsairs and Hellcats defending the fleet to intercept every kamikaze. However, American engineers refurbished captured airfields at an astonishing rate. Both Yontan and Kadena airfields were captured within hours of the initial landings on Okinawa. These strips were soon used to base Allied fighters to fend off the kamikaze attacks, freeing the vulnerable US carriers. By the end of May, the Japanese military leadership realized that the defenders on Okinawa would not persist. The last Kikusui attack took place on

June 22, 1945. According to Masatake Okumiya, nearly half of the aircraft that successfully carried out their suicide missions were Zeros.

Okinawa

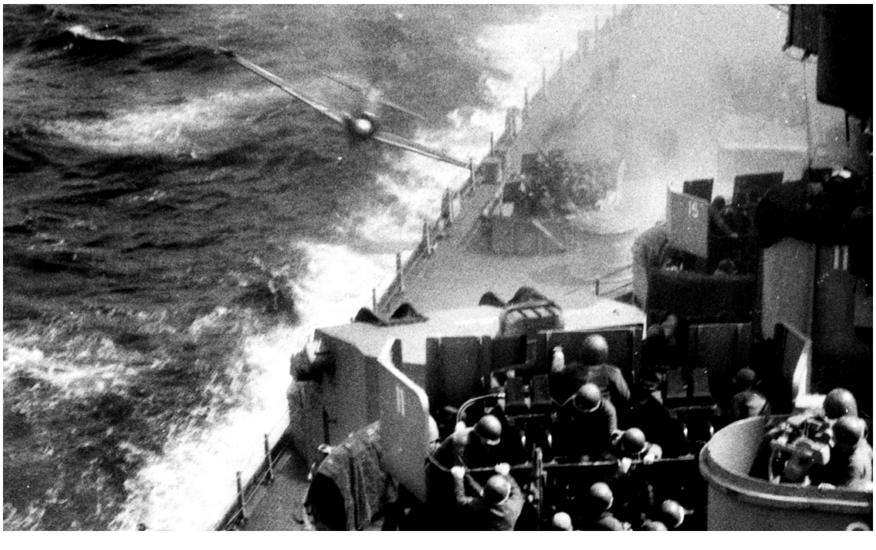
Although the Zero was outdated in comparison to the Kawanishi N1K2 Shiden-Kai, it still possessed better range. This key factor made the Zero favored for escort duty for kamikaze aircraft during the Okinawa campaign. One of the most distinctive Zero outfits to fight over Okinawa was the 131st Kokutai. Zero pilots from this unit trained to execute traditional attack missions at night against Allied airfields and shipping. The 131st had both Zeros and Judy dive bombers, and began operations over Okinawa on April 1, 1945. Over 200 Zero sorties were flown against the Allies over Okinawa. The unit faced stiff resistance from both night-fighters and a near-impenetrable wall of shore-based and ship-based antiaircraft fire. Astonishingly, this highly skilled unit lost only seven Zeros and 16 Judys.



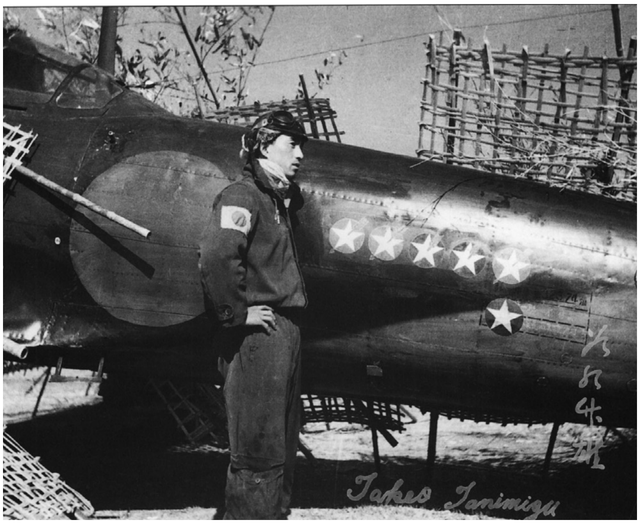
A mix of A6M2-K and A6M2b trainer aircraft assigned to the Genzan Group, Wonsan, Korea, late 1944. Many of these were later used as kamikaze aircraft during the battle for Okinawa. (IJN)

Homeland defense

The first B-29 Superfortress raid over Japan took place on June 15, 1944, against steel works production in Yahata. While no aerial opposition greeted the first mission, the B-29 crews failed to cause any significant damage. These early B-29 operations continued to struggle for the first couple of months. This changed with new leadership and as B-29 crews became more familiar with their aircraft and targets. The IJN crews facing the B-29s from the China–Burma–



A Zero flies just above the water moments before impacting the battleship USS *Missouri*, Okinawa, Japan, April 11, 1945. The ship's quad 40mm gunners attempt to fight off the attack. The *Missouri* suffered only minor damage from the impact. (NARA)

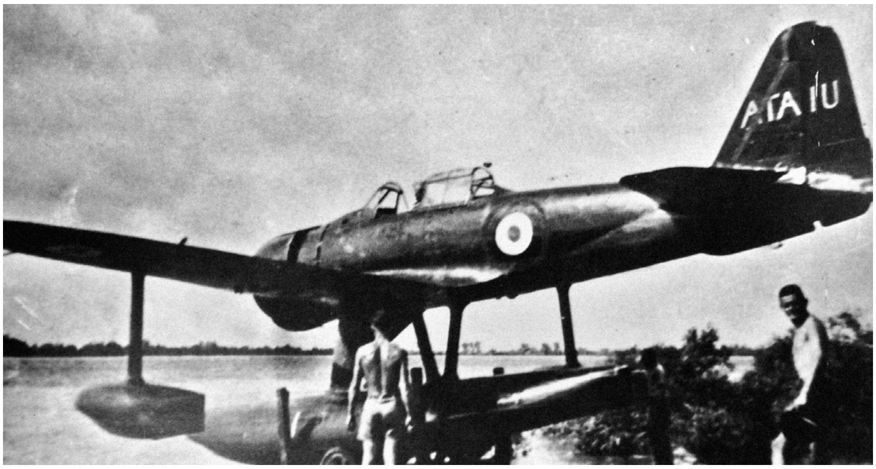


Chief Petty Officer Takeo Tanimizu, assigned to the 203rd Kokutai, stands next to his Nakajima Works A6M5c Model 52-*Hei*, with its impressive scoreboard. The kill markings cover up part of the aircraft's data stencil. (T Tanimizu)

India theater were from the 302nd, 352nd, and Omura Kokutais, flying Zeros (both day and night-fighters), Gekkos, Judys, and Raidens. On August 20, 1944, Zero pilots from the 352nd Kokutai claimed their first victory over a B-29 as it attacked the Yahata steel works. On October 25, B-29s from the 58th Bomb Wing attacked aircraft factories in Omura. On this occasion, Lt (JG) Koichi Sawada of the 352nd claimed one B-29 while flying an A6M5 night-fighter. On November 21, IJN fighters met the B-29s over Omura during daylight hours and claimed nine, one of which was destroyed by ramming. Ramming attacks became more frequent as the B-29 raids persisted. It was seen as an effective way to bring down a B-29, when little else seemed to stop the bombing attacks.

The first B-29 raid on Tokyo took place on November 24, 1944, when B-29s flying out of the Marianas attacked the Nakajima engine plant. IJN fighters were launched but failed to intercept the enemy. The 352nd Kokutai launched 43 aircraft to intercept B-29s on December 19, and claimed two B-29s, but lost two Zeros, including Sawada's. The Superfortresses went after Nagoya's aircraft industrial complexes on December 13 and 18. These were met by IJN interceptors, which nonetheless failed to stop the bombers from devastating their targets. On December 27, an A6M5 night-fighter pilot, Lt Jusaburo Mukai, claimed a B-29 over Nagoya by firing on it with his fuselage-mounted oblique 20mm cannon. The interceptors engaged again on January 27, 1945, while B-29s hit Tokyo, and made the astonishing claim of shooting down 22 B-29s. The actual score amounted to five bombers destroyed over Tokyo, and two that had to ditch. In all, over 30 B-29s were damaged out of 75 that participated in the raid.

In March the B-29s switched tactics, dropping incendiary bombs from low altitudes at night. The first fire-bombing attack against Tokyo came on the night of March 9. The Japanese defenses claimed to have destroyed 14 of over 300 bombers that participated. Their claims at this point meant little as Tokyo burned. The B-29s continued these tactics, devastating Japan's industrial centers.



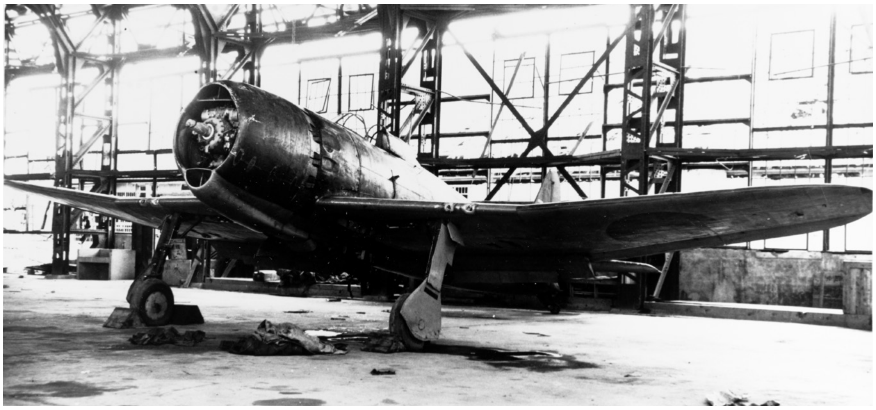
After being evaluated by the Allied Technical Air Intelligence Unit (ATAIU), this A6M2-N went on to serve with the French Navy, assigned to the 8th Squadron stationed at Cat Lai, French Indochina. The aircraft was lost in an accident on February 19, 1946. (British official photograph)

During this period, the US Navy's Task Force 58 compounded the Japanese defense's problems as they attacked mainland Japan on February 16–17. The air battles that ensued between the US Navy and the IJN fighter pilots went heavily in favor of the Americans. Although the Zero had long since lost its inherent advantages, when flown by a skilled pilot it was still deadly. On the second day of the raid, a Zero flown by Lt (JG) Sadanori Akamatsu claimed two Hellcats over Tokyo Bay, and later shot down two more F6Fs over his home base of Atsugi. Despite these losses, US Navy aircraft continued to reach their targets. When the USN launched a second raid in March, they met their stiffest resistance yet, facing off against the 343th Kokutai – made up of veteran pilots flying the IJN's best fighter of the war, the Kawanishi N1K2 Shiden-Kai. However, even the best results from this outfit could do little to stop the onslaught. The Shiden-Kai was fielded too late and produced in too small numbers to change the situation. Once again Japan had to depend heavily on the Zero, based on its availability.

Top five Zero aces (1941–45)	
Hiroyoshi Nishizawa	87
Tetsuzo Iwamoto	80
Shoichi Sugita	70
Saburo Saki	64
Takeo Okumura	54
(Majority of kills while operating A6Ms)	
Note: The scores above have been given in multiple sources, however, IJNAF aerial victory claims are nearly impossible to substantiate, due to early unit scoring, and over-claiming.	

CONCLUSION

In many ways, the Mitsubishi Zero's history is a metaphor for Japan's successes and failures during World War II. At the start of the war, the Zero – as with Japanese forces in general – shocked and humbled Western countries who had underestimated their enemy's capabilities. The Japanese aerospace industry was not taken seriously (out of prejudice as well as failed intelligence), nor did the Allies take into account Japan's highly skilled naval aviators. Even when experts like Claire Lee Chennault sounded the alarm after witnessing the A6M2 in action, Allied intelligence failed to appreciate the significant gains made by Japan.



The Mitsubishi A7M *Reppu* or "Strong Gale" (Allied reporting name Sam) was Horikoshi's last design of the war. After the IJN authorized full production, an Allied bombing raid destroyed both the plans and tooling for the aircraft. This was followed by a major earthquake that hit Nagoya in December 1944. (USN)

This Nakajima Works A6M5 (manufacturer number 5357) was purchased by the Planes of Fame Museum in Chino, California in 1950. The aircraft was restored to flying status in 1978, and is currently the only example of a flying Zero powered by its original Nakajima Sakae engine. (NARA)

The Zero was built in response to the needs of the IJN during the Second Sino-Japanese War. In a short period of time, Mitsubishi created the world's first long-range escort fighter, and one of the first carrier-borne fighters to outperform its land-based contemporaries. When compared with aircraft of the same period (1939–40), the A6M was one of the finest fighters built. The Mitsubishi's ability to turn inside its opponents forced the Allies to dramatically change tactics. After suffering staggering losses during the first year of the war, Allied pilots were warned not to get into a turning dogfight with the Zero. Joe Foss, one of the Marine Corps' top aces, brilliantly summarized early American impressions of the Zero to a group of Australian pilots: "We have a saying up at Guadalcanal, if you're alone and you meet a Zero, run like hell because you're outnumbered."

With the aid of brilliant tacticians and captured Zeros, US forces discovered ways to defeat the near-mythical Zero. By 1943, the IJN still had no replacement for the Zero. The design had largely gone unchanged since air battles over China in 1940. In fact, the IJN looked upon the Zero to fulfill multiple missions as the war progressed, altering it for use as a float-fighter, fighter-bomber, trainer, and night-fighter. The Zero excelled in many of these roles, and was considered one of the best dive bombers to serve with the IJNAF. Despite its versatility, however, the Zero's greatest downfall was its unwarranted longevity as a frontline fighter. Allied forces rapidly replaced their early war fighters with newer designs like the F6F Hellcat, the Chance-Vought F4U Corsair, and the Republic P-47 Thunderbolt. Meanwhile, however, the Japanese improvements to the Zero were merely stopgap measures, intended as interim solutions until newer fighters could be fielded. By the time the IJNAF started replacing land-based Zeros in frontline units with Mitsubishi Raidens and Kawanishi Shidens, it was too little, too late. Furthermore, development problems plagued these new interceptors along with the Zero's true successor, the Mitsubishi A7M Reppu carrier-fighter. These issues, and Japan's inability to mass-produce fighters, forced the IJNAF to continue to rely heavily on the outdated Zero. Finally, when Japan faced imminent defeat in 1944, the once cutting-edge Zero was utilized to take the lead in the nation's kamikaze effort.

A Japanese Air Self Defense Force (JASDF) ground crew prepares a Lockheed-Martin/ Mitsubishi F-2A Viper-Zero for a mission during Exercise *Cope North*, Andersen AFB, Guam, February 21, 2014. (USAF)

Dr Jiro Horikoshi and the Mitsubishi Zero are still highly revered in Japan. In 2013, two movies – one an animated feature titled *The Wind Rises*, created by world-renowned animator and director Hayao Miyazaki, and a second film (a live-action movie) titled *The Eternal Zero*, directed by Takashi Yamazaki – were released. The animated feature was loosely based on Jiro Horikoshi's life and focused on aeronautical design and the engineering aspects of creating the Mitsubishi Type 96. The second film, based on a piece of historical fiction by Naoki Hyakuta, focused on the life of an individual Zero pilot. Both films were blockbuster successes in Japan. The Mitsubishi A6M is celebrated in Japan in a similar manner to which the British venerate the Spitfire, or the United States the P-51 Mustang. The name "Zero" is still used today within the Japanese Air Self Defense Force, just as the United States names its modern military aircraft after legendary fighters from the past (A-10 Thunderbolt II/P-47 Thunderbolt). The Mitsubishi F-2 uses the popular name "Viper-Zero" in honor of Japan's greatest fighter.

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Key

1. CS40B three-bladed constant-speed propeller
2. Spinner
3. Carburetor air intake
4. Oil cooler air intake
5. Nakajima Sakae-12 air-cooled radial engine
6. Oil tank: 58 liters
7. 145 liter fuel cell
8. 330 liter drop tank
9. Left main gear/wheel cover
10. Type 99 Mk1 20mm cannon (x2)
11. Twist down (wash out) leading edge
12. Pitot tube
13. 50cm folding wing tip/navigation light
14. Fabric covered aileron
15. Split flaps
16. Retractable entry step
17. Arresting hook
18. Tail wheel (not visible)
19. Fabric covered elevator
20. Removable tail cone/navigation light
21. Fabric covered rudder
22. Wooden antenna mast/radio antenna
23. Carbon dioxide bottle
24. Battery
25. Homing loop antenna
26. Head rest/anti-roll support
27. Oxygen bottles
28. 190 liter wing fuel cell (x2)
29. Adjustable pilot seat
30. Type 98 reflector gun sight
31. Type 97 7.7mm machine gun (x2)
32. Cowl flaps
33. Aileron control hinge
34. Formation lights
35. Navigation light

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MITSUBISHI WORKS A6M2 MODEL 21 (DI-108), PO1/C TADAYOSHI KOGA, JUNE 4, 1942.

This Mitsubishi Works A6M2b (serial number 4593) became known as "Koga's Zero," named after PO1/c Tadayoshi Koga. Koga's A6M2b was hit by ground fire while attacking Dutch Harbor, Alaska on June 4, 1942. Koga attempted to land his damaged aircraft on Akutan Island, a predesignated emergency landing site. Upon landing, Koga's gear mired in mud, flipping the Zero over on its back, killing Koga instantly. Two pilots escorting Koga could not bring themselves to destroy the downed Zero, as there was a chance that Koga was still alive in the wreckage. The Zero was spotted by a US Navy PBY crew on July 10, 1942. The aircraft was recovered and sent to Naval Air Station San Diego, California for repairs and flight analysis. The aircraft was later painted in a US Naval color scheme and given a Bureau number (4593) that corresponded with its original Mitsubishi serial number. The first test flight took place on September 20, 1942, by Lt Cmdr Eddie R. Sanders. The tests and thorough study of Koga's Zero revealed both the strengths and the weaknesses of the Mitsubishi fighter, and were instrumental in combating the A6M2. The once-prized Zero did not survive the war, as it was destroyed in a ground accident with a Curtiss SB2C Helldiver in early 1945.